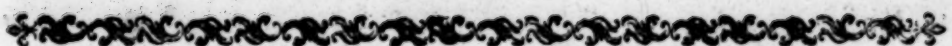


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E S S A Y

Introductory to the STUDY

O F

ELECTRICITY.

[Price Three Shillings.]





Becket (J. B.)
H A N
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O N
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CONTAINING

A Series of EXPERIMENTS

Introductory to the Study of that SCIENCE;

In which are included

Some of the latest DISCOVERIES;

INTENDED CHIEFLY

With a View of facilitating its APPLICATION,
and extending its UTILITY

In MEDICAL PURPOSES.

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at *Bath*; and E. SCORE and B. THORN, at *Exeter*.

MDCCCLXXIII.



ADVERTISEMENT.

SEVERAL Persons in this City, who have lately furnished themselves with ELECTRICAL MACHINES, have repeatedly desired me to give them a few plain Directions for the Use and Management of it—to put them in a Method of adjusting the Apparatus for various Purposes, and to draw up a Series of such EXPERIMENTS as might tend to facilitate the Study of the Science.

I sate down the more readily to attempt this, from observing that verbal Directions, and even repeating the Experiments before them, were seldom sufficient either to convey a proper Idea of the Nature of Electricity, to those who were Strangers to it, or to prevent their being frequently at a Loss in some Part of the Operation.

I had, at first, no farther Intention than merely to draw up such Directions and Observations as immediately occurred to me, for the Use of a few Persons who particularly desired them; but being at the same Time desirous of promoting a farther Enquiry into the Subject, which I am perswaded is of some considerable Importance to Mankind, I was led by this Motive to collect several of the most useful Observations from judicious Writers; and, by adding some of the latest Discoveries, to exhibit a short View of the present State of Electricity, which I am now induced to commit to the Candour of the Public, whose Favours already conferred, will be ever gratefully acknowledged, by

Their devoted,

and obedient Servant,

BRISTOL,
May, 1773.

J. B. Becket.

C O N T E N T S.

P A R T I.

*O*F the Nature and Properties of the ELECTRIC FLUID, with a Series of Propositions illustrated by easy EXPERIMENTS; and Directions for the Use and Management of an ELECTRICAL MACHINE.

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Of the ELECTRIC FLUID.

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T H E
P R E F A C E.

NOTHING, perhaps, has contributed more to the establishment of Truth, and the advancement of genuine Science, than the transition from METAPHYSICAL *Reasoning* to EXPERIMENTAL *Philosophy*. Mere *Conjecture*, however plausible or fondly embraced at first, affording at length but little satisfaction to the mind, we are constantly wishing for the *Evidence of Facts*; and finding but few speculative Points but what are liable to be controverted, we are obliged to seek for demonstrative Proof by adverting to *practical Investigation*.

THIS is eminently true with respect to ELECTRICITY—a field of enquiry wherein *Fancy* has, indeed, sufficiently exhibited her luxuriance. No other Science has had more admirers, nor been subject, in so short a space of time, to so great a variety of *Hypotheses*: These have been *changed*, *corrected*, and *improved*, almost as often as the In-

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struments

struments and Machines which have been made use of upon the occasion. Indeed, so little of the nature of Electricity was known before the Apparatus became considerably extended, that even the *existence* of the Agent seems to have been a matter of speculation; but, after the Instruments had demonstrated that such a Fluid actually *existed*, the *mode* of that existence was altogether undetermined, and became a subject of much dispute.

SOME have supposed the electric matter to be a kind of *unctuous Effluvia* arising, by means of friction, from substances termed *electrics per se*;—Others, the *Æther* pointed out by Sir ISAAC NEWTON, in the effects of which, a certain *subtile Medium* was concerned.—Some called it *Elementary Fire*, and imagined it to be a modification of the Fire they termed an *Element*; while others conceived it to be a fluid distinct from chymical fire, but of a nature greatly resembling it.

AFTER two opposite and remarkably distinct Effects had been observed in the attractive and repulsive

pulsive powers of electricity, according as they were excited in different substances, the *Theories* of electricity became more complex; and a few gentlemen, with M. DU FAYE at their head, asserted the existence of *two distinct fluids*, (which they called the *vitreous* and *resinous* electricity) in order to account for the different phenomena which they observed to arise from the excitation of such substances.—To these hypotheses may be added the ingenious Abbe NOLLET's fanciful doctrine of electrical *affluences* and *effluences*, which he so strenuously maintained to so little purpose.

WHEN it was discovered that this *twofold* electricity might be procured by one and the same substance, and from the same machine, the subject appeared entirely in a new light, and the terms were presently changed from *vitreous* and *resinous* to those of *positive* and *negative* electricity, as being much more adequate and expressive of the fact; and the appearances which were afterwards produced by means of this discovery, seemed suf-

ficient to establish the opinion that all electrical phenomena are effected by one fluid *sui generis*, extremely elastic, and attached to the particles of all other matter.

For this theory of electricity, which of all others appears to be least embarrass'd with difficulties, we are chiefly indebted to Dr. FRANKLIN, many of whose *conjectures* on the subject (candidly offered to the world in that form) are now found to be verified and established by actual experiment.

THE intention of the following sheets being chiefly to promote a more general enquiry into the nature and properties of the electric fluid, by facilitating the practical part to those who have been but little conversant with the subject, I shall not attempt to illustrate any other *theory* than that which is now generally received, from its appearing to be the most rational and consistent.

THE late discoveries in electricity, which that of the *Leyden phial* has given rise to, together with the agreeable entertainment it affords, have
incited

incited great numbers to engage in it merely for the sake of amusement, which, indeed, has sometimes led to farther improvements, but it has also been productive of many useless and trivial experiments, some of which are too puerile to be worthy of much notice. It now appears, however, that electricity may be apply'd to purposes much more important than merely to fill up the vacancy of a leisure hour. It seems to be a clew leading into many of the *labyrinths of nature*, which human industry has never yet been able to unfold.

FORTUNATE as the discovery of electricity appears to be, we have yet some cause to lament that it came too late to be investigated by the penetrating genius of a NEWTON or a BOYLE—but an ELECTRICAL MACHINE in such hands, would have explored greater depths than were destined for the discoveries of one æra,—these were, perhaps, reserved for the present, or future periods of time; which, if this track of philosophy be pursued, may be productive of the most propitious events.

ELEC-

ELECTRICITY seems to be a branch of science in which pleasure and utility are happily united. Were the subject to be attended to in no other than a *philosophic* light, with a view of extending our knowledge of a fluid which appears to have almost an unlimited agency, and universal extent, it would be found to be an inexhaustible source to the man of leisure and speculation ; or, if we consider the variety of entertaining experiments and curious phænomena that may be produced by an electrical machine, we shall find it to be a most agreeable relaxation to every mind that is capable of virtuous and rational pleasures : But if, at the same time, it can be rendered subservient to more material purposes in life, it must strongly demand the attention of every ingenious and liberal enquirer.

Two great advantages accruing to mankind from the knowledge they have already attained of the nature of electricity, are, a method of preserving buildings from the destructive effects of LIGHTNING—and, the addition of an article to the *Ma-*
teria

teria Medica which has frequently been made use of with singular success.

IT was with a view of extending the utility of the latter, that I have in some of the subsequent pages, collected the sentiments of different writers on the subject, and exhibited the particular methods which have been used in applying electricity for the cure of various disorders of the human body.——To these I have added a collection of CASES and CURES, in order as well to point out what species of disorders is most likely to be benefited by such treatment, as to limit the application within proper bounds.

I HAVE also selected such EXPERIMENTS as have a tendency both to facilitate the Practice, and to illustrate the general Theory of Electricity.

THOSE who are acquainted with the subject, will likewise observe that I have chosen the recital of evident and *known Facts*, rather than the obtrusion of any uncertain conjectures of my own—those few that I have been led to advance, I desire to submit to the candid examination and correction of the unprejudiced electrician.

ERRATA.

Page 2, line 21, *for they are read it is.*

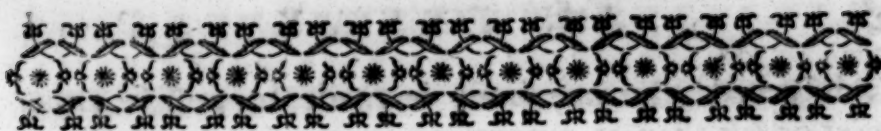
P. 3, l. 2 (from the bottom) *for chair read chain.*

P. 30, l. 20, *for and positively read and the other end positively.*

P. 44, l. ult. *for pungeant read pungent.*

For the late Dr. FRANKLIN (wherever it occurs) read Dr. FRANKLIN.

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E S S A Y

On ELECTRICITY, &c.

P A R T I.

*Of the Nature and Properties of the ELECTRIC FLUID,
with a Series of Propositions, illustrated by easy Experi-
ments; and Directions for the Use and Management of
an ELECTRICAL MACHINE.*

S E C T. I.

Of the ELECTRIC FLUID.

 AMONG other constituent principles which form the material world, there has been discovered an amazingly subtile and elastic fluid, generally term'd *electric*. This fluid is supposed to be universally diffused in all bodies, and so far inherent, as to be inseparable from them but by *force*. The earth, the air, water, and all other substances that we know of, contain a certain quantity of the electric matter, which is said to be *natural* to them. As long as this natural quantity remains in any substance, its effects are invisible, and we are totally insensible of its power; but, whenever the equilibrium
B is

is disturbed, and any body is made to possess either *more* or *less* than is natural to it, we are immediately sensible of the effects, and the balance is as perceptibly destroyed, as when we increase or diminish the weight of either end of a scale-beam.

WERE all bodies possessed of an equal power of retaining, and of parting with the electric fluid, we should neither have the means of exciting its appearance, nor become, in any measure, sensible of its effects; but because some substances freely admit of its passage through their pores, while others seem to be nearly impermeable to it, we may easily disturb the equilibrium, by making the fluid pass from one body to another, by means of friction; and, when it is thus accumulated or collected in any body, it may as easily be detained, for some considerable time, by supporting the electrified body on such other substances, as will not admit of the fluid's passage.

WHEN any body is thus supported by others that obstruct the passage, or cut off the communication of the electric fluid with the earth, ~~they are~~^{it is} said to be *insulated*.

ALL substances that freely permit the fluid to pass through them, are called *non-electrics*, or *conductors*; and those which are found not to admit of such free passage, are termed *electrics*, or *non-conductors*.

METALS of every kind, are the most perfect conductors; next to these are *charcoal*, and the *fluids* of the *animal body*; *water* is also found to be a good conductor; *green vegetables*, *moist wood*, *flax*, &c. conduct in a less perfect degree.

THE best electrics, or non-conductors, are *glass*, *sealing-wax*, *sulphur*, *rosin*, *bees-wax*, and *baked wood*; the *air*, when free from moisture, is also a very perfect electric; and most kinds of *oil*, *filk*, and *hair*.

WHEN any perfect electric is rubbed with one that is less perfect, the electrical fluid will leave the latter, and

and be accumulated upon the former; Thus, in working a common electrical machine, the glass globe, or cylinder, having a light pressure, and friction against the leather cushion, or rubber, the fluid is collected from the rubber, from the person who turns the machine, from the table, &c. or rather, *through* all these, from the earth. It is accumulated on the surface of the glass, from which it is immediately received by the sharp-pointed wires, called the *collectors*, and, through them, conveyed to the *prime conductor*; this being supported either by glass, silk, or some other electric, the fluid will be detained on it till it is imbibed by the humidity of the air, or taken off by the approach of some conducting substance. If a person presents a piece of metal, or the knuckle of his hand, to the conductor, the electric matter will fly off in a strong spark, and be re-conducted to the earth through his body.

THAT the electric fluid is collected chiefly from the earth, may be rendered very evident, by insulating, or cutting off the communication of the rubber, by means of glass, or a piece of baked wood; though the machine acts now, with ~~the~~ same vigor it did before, yet, after one or two small sparks be drawn, no more of the electric fire will issue from the conductor, except the very small quantity collected from the air. But, in such circumstances, if a chain be hung from the rubber, so that one end of it may touch the table, the fire will be produced as before, and, in a dark room, there will be an appearance of several bright sparks on the chain. If a person points his finger to the rubber (the chain being taken away) ~~the~~ fire will

B 2

be

* Every machine, intended for experiments, should be furnished with this convenience, for occasionally insulating the rubber; as, without some such method, a person will be apt to conceive but a very imperfect idea of the nature of the electric fluid.

be seen to issue from it, to the rubber, in a beautiful pencil of rays.

IF the machine be not furnished with an insulated rubber, we may take another method to prove that the electric matter proceeds from the earth. Let a person take an electrical glass tube, and, by drawing his hand, with a piece of flannel in it, over the surface, he will presently find the tube become electrified. The matter, leaving his hand, passes to the glass, where it remains, as an addition to its natural quantity; for, as neither the glass nor the air are conductors, the redundancy of the electric fluid cannot escape, till some non-electric body approaches it. If a piece of metal, or the hand, be presented to any part of the tube, the fluid will pass from it to the metal, with a crackling noise, and, in the dark, long flashes of fire may be seen. But, if the person that rubs the tube stands upon a stool, or board, supported by glass legs, he will be circumstanced like the insulated rubber. Another person, on the floor, applying his knuckle from one end to the other of the excited tube, will, after the first or second time, be able to get no more fire from it, as none can go to it from the earth. The person standing on the stool will then have a *deficiency* of his natural quantity of the fluid, or become electrified *negatively*, (which term will be farther explained hereafter) and, if he touches any other person, will receive a spark, which again restores the balance.

THAT the electric fluid is of a nature highly elastic, and its particles strongly repulsive of each other, appears evident from the amazing spring and velocity which it acquires, when condensed; and we find its subtilty, and rapidity of action to be such, as instantly to pervade the pores of the most dense and solid metals, the moment it is released from a state of compression; and this may be effected through a circuit several miles in length.

THE

THE similarity of the appearance and effects of the electrical fire, to those of *lightning*, has been remarked, by writers on the subject, some years since. The late Dr. FRANKLIN, of *Philadelphia*, and some other ingenious gentlemen, have, by several conclusive experiments, proved the *cause* and *effects* of both to be not only similar, but have also demonstrated their identity: So that the *explosions* which are produced by means of an electrical machine, are no other than *thunder and lightning*, in miniature, divested of their tremendous effects. The appearance and effects of lightning, may be exactly imitated by electricity; and most electrical experiments may be performed by the electric matter drawn from the clouds, by means of silk kites, raised during a thunder-storm, or by pointed iron rods, erected on the top of a building.

MANY other phenomena, and appearances of nature, may be agreeably imitated and explained by electricity; viz. the *aurora borealis*,—a *tornado*, or water-spout from the Sea—a *whirlwind* on the land, &c.—but of these hereafter.

PHILOSOPHERS are not yet entirely agreed in opinion whether the electric fluid be of the same nature, and a modification of *fire*, or whether it be a fluid *sui generis*. There are, at least, some few gentlemen who, in order to strengthen a favourite hypothesis, have taken great pains in attempting to prove the identity of common, or, as it is generally termed, *culinary fire*, and *electricity*; but it must be confessed that neither their arguments nor experiments appear, by any means, sufficiently conclusive. The luminous appearance of the electric fluid, and more especially, its being capable of kindling inflammable substances, have been common and plausible arguments in support of this opinion; but these are far from being satisfactory to the unprejudiced mind.

WE

WE know there are many substances in nature which, in the dark, assume a lucid appearance, but in which, one of the most essential properties of *fire* is wanting. As all kinds of *friction* and *collision* are, more or less, productive of *heat*, it seems to be with great propriety that we always annex an idea of *heat* with *fire*; the former must be a necessary consequence of the latter, which is supposed to be a *peculiarly violent agitation*, into which the inflammable parts of bodies are thrown, by a certain degree of friction, which is necessary to *generate* or *produce* it.

If the above definition of fire be admitted, (and I think we have the authorities of a BACON, a BOYLE, and a NEWTON to support it) it seems not much to be wondered at, that the parts of substances which are easily inflammable, should be kindled into fire by the rapid transition of the electric fluid through them.^b Nor is the consequence of so sudden and violent a friction more than what might be expected, when we find that wires, of some considerable thickness, may not only be made red hot, but may also be put into a fusion, and even be vitrified, and entirely dispersed, by a strong electric

^b In a Tract written by Dr. HOADLY and Mr. WILSON, intitled "*Observations on a Series of Electrical Experiments*," is the following observation,—“It is improper to call the *Electric Fluid* FIRE; Air may just as properly be called Sound, as this fluid may be called Fire. When sound is produced, the particles of air are put into so regular a motion, as to convey such sensations, by means of the ear, as raise the idea of sound. But air is not therefore sound. In the same manner, when a body has all its component particles thrown into such agitations in the air, by the force and action of this fluid within it and without it, that it grows hot and shines, and glows and consumes away in smoke and flame, we say the body is on fire, or burns: But this fluid is not therefore *fire*; nor can it, without confounding our ideas, have that name given to it: Nor indeed can *fire* be called a principle or element, in the chymist's sense of the word, any more than sound can.

electric *explosion*, and this in an instant of time; which is not to be effected by the most ardent culinary fire that we are able to procure.

BUT, if we suppose the electric matter, and fire, to be the same, there seems to be a difficulty in accounting for the remarkable difference which appears in the modification and effects of the electric spark, and that which is produced by the collision of flint and steel. When the electric fluid is accumulated on the prime conductor of a machine, the spark may be drawn from it at the distance of several inches, and it flies off with so great a rapidity, that we are not able to distinguish its direction, whether it proceeds *to* or *from* the conductor; and in the instant that the spark is drawn, it intirely disappears, and seems to be totally enveloped in the common mass of matter: on the contrary, the spark from the steel has a comparatively slow progressive motion, and, when received upon the surface of any body, it will sometimes remain a considerable time, before it becomes extinct; nor has it any appearance of the power of attraction, or repulsion.

IN the smallest spark of *fire*, there is a sensation, or quality, of *burning*, and *heat*; but in one, much more lucid and intense, taken by the knuckle from the electrified conductor, no degree of heat is perceptible.

A VERY considerable quantity of the electric fluid may be condensed in a coated glass receiver, without being rendered visible; but the imagination must be somewhat strained, in the conception of such a quantity of *compress'd fire*, intense and, at the same time, *invisible*.

A DENSE *air* is found to be necessary to the existence of culinary fire, but the electric fluid evidently subsists *in vacuo*, at least, in the most perfect vacuum that we are able to procure. Many other reasons, and experiments, might be advanced, to shew that our ideas of *electricity*, and of *fire*, ought not to be confounded, though the former may produce the latter in abundance
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of instances;—but as my design here, is by no means to controvert the opinions of others, I have mentioned the preceding observations with no other intent than to guard against the admittance of any hasty and immature conclusions. Indeed we know so little of the origin and extent of *fire*, that it cannot appear strange, if men of the greatest penetration have been divided in their opinion of it; and, after it has been subject to the investigation of the illustrious persons before named, the decisions of future enquirers should be pronounced with a becoming diffidence.

With respect to the *electric fluid*, we are able, by the help of the machine, and its appendages, to investigate several of its properties with some degree of precision; though concerning others, it must be confess'd that we can yet do little more than conjecture: The most probable opinion, however, seems to be that of Dr. FRANKLIN, who supposes it to be fluid *sui generis*, universally dispersed through the pores of all bodies.* This gentleman, as before observed, has satisfactorily proved that it is of the same nature as *lightning*, extremely subtile and elastic, its particles strongly repulsive of each other, and attractive of the particles of matter; most of these Properties may be clearly demonstrated by experiments, for which purpose several of the following are designed.

S E C T.

* Whoever are desirous of seeing this subject properly handled, I would refer them to the perusal of Dr. FRANKLIN's Letters, most of which have been published in the Philosophical Transactions, but are now collected into one volume;—and to the History and Present State of Electricity, written by the ingenious Dr. PRIESTLEY, a work I shall venture to recommend to the perusal of every person who has an inclination of making himself acquainted with the subject, as far as it is hitherto known.

S E C T. II.

Of the ELECTRICAL MACHINE, with Directions for the Use of it.

THESE Machines, since Electricity has become a common subject of enquiry, have been made in a great variety of forms, and on different constructions. Few of them are very complicated; but the machine which, on some accounts, I would prefer to any other, and which answers every necessary purpose, is the most simple that can well be conceived. It consists of a glass cylinder, 12 or 14 inches in length, by 9 or 10 in diameter; smaller than this will not so well answer the purpose. It is turned, in a vertical direction, by a single wince, without any accelerated motion from wheels, and without any axis, or spindle thro' it. The rubber, or cushion underneath, is supported on a brass spring, and may be *insulated* or otherwise, at pleasure, by means of a plate of glass, adjusted to a socket. The *prime conductor* may be placed either on the right hand, or left, as is most convenient. There is also a *negative conductor*, of the same form and size as the *positive*, or prime conductor: They may be supported either on glass stands, or phials, and placed in any required direction, or distance from each other, by which means both the *positive* and *negative* electricity, may be obtained without the least trouble.

THE most material thing in a machine is a good cylinder, (which, for many reasons, is preferable to a globe) made of a proper glass, form, and substance; that will be excited with a gentle and easy friction. I have always found those cylinders to act the best that are lined on the inside with a thin lining of electric

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substances. The following composition is a very good one for the purpose; Half a pound of rosin, half a pound of bees-wax, with two pounds of venice turpentine, boiled for two hours over a gentle fire, keeping them stirred; a small quantity of vermilion may then be stirred in with it, and afterwards left to cool. A sufficient quantity of this mixture is then to be put into the cylinder, which must be turn'd round, over a clear fire, till it is evenly spread over all the inside, and then left gradually to cool.

THERE is frequently a very material difference in the nature of the glass with which the cylinders are made. I have tried several sorts both of green and white flint, but with so various success, that I cannot pretend to determine which is to be preferred. I have had many cylinders, to all appearance, very well made, but which could by no means be excited; till after having the above lining, they have proved extremely good: Indeed I never yet met with a lined cylinder but what acted tolerably well; and I have generally found that the longer they have been made, and the more frequently they are used and rubbed, the more powerfully they may be excited.

WHEN the cylinder is in good order, and acts vigorously, on presenting the knuckle near it, there will not only be a sensible wind, a hissing noise, and stream of light from it, but very bright sparks, and circles of fire will be seen to dart from the knuckle, over the surface of the cylinder, to the rubber, the contrary way to which the cylinder is turned, attended with a snapping noise, and tingling sensation in the part from whence it seems to issue: But this will not always be the case, nor is it requisite,—if an air be found to come from the cylinder, attended with a crackling noise against the knuckles, the machine will act strong enough for almost any experiment. If nothing of this
be

be perceived, the cylinder must be gently rubbed with a piece of flannel, or a soft, dry handkerchief; sometimes, particularly in damp weather, and when the machine has not been used for some time, it will be necessary to bring it for a few minutes before a fire, and to make the cylinder a little warm. If this does not do, take off the rubber, and lightly stroke the surface of it with the end of a tallow-candle, and afterwards rub over it a small quantity of what is called *Amalgam*;^d this seldom fails to make the cylinder act with much greater strength. Sometimes merely rubbing the surface of the rubber with the end of the finger, in order to take off a kind of polish, which in time it acquires, will be sufficient to give the machine fresh vigor. If the amalgam be used, the cylinder requires to be wiped occasionally, to get off the black rough matter, that will sometimes be found sticking to it.

THOSE cylinders that will act with a light pressure against the rubber, and a motion moderately swift, are always the best, as they save much labour in working the machine; and it will generally be necessary to adjust the rubber, and put the cylinder in proper order, before any experiments are entered upon; and afterwards, occasionally to tighten or slacken the adjusting screw. After the cylinder has been worked for some time, it will be found to turn less easy than it did at first, as though it pressed too hard against the rubber, and less fire will generally be produced; in this case, a coarse linen cloth, on which has been rubbed a small quantity of candle-tallow, may be held against the cylinder as it turns, and it will immediately turn easier, and act as vigorous as before. c 2 BUT

^d This is a composition which no person that has a machine, should be without, as it never fails to increase the power of it. The Amalgam is usually made of *quicksilver*, and the scrapings of *pewter*, *lead*, or pieces of *tin-foil*, mix'd together, in a hot marble or glass mortar; if a small quantity of *vermilion* and *bismuth* be added, this mixture will be found very serviceable.

BUT however well the cylinder may act, it will be in vain to expect any experiments will succeed properly, unless the prime conductor be *perfectly insulated*. It may easily be known if it be not so, by taking a spark from it, which will never be strong, nor drawn but at a small distance. If the conductor be supported on glass, this must be rubbed perfectly dry, or held to the fire, till it be somewhat warm; or if silk lines be used, the same drying will be necessary. All roughnesses, edges, and points on the conductor, or its supporters, that may throw off the fluid into the air, should be properly secured, and rounded off.

THE pointed wires, or collectors of the fire, should be placed within half an inch of the cylinder, directly facing, or parallel with the rubber, so that all of them may be within the central force, and greatest influence of the glass; for if any of the wires extend too far toward either end of the cylinder, instead of collecting, they will throw off the fluid, which, in the dark, may be seen in the appearance of a small stream of blue fire, extending itself toward the end of the glass; the collector should then be moved, either one way or the other, till the points of all the wires are illuminated with a star, or speck of light, without a stream from any of them. For this reason, the rubber ought generally to be about two inches shorter than the cylinder, and the extent of the wires less than the length of the rubber, by at least one inch.

I HAVE been the more explicit and particular in these directions, because I am sensible that the young Electrician frequently undergoes no small degree of vexation, when he is not able to collect a sufficiency of fire for his experiment, and is at a loss to know the reason: Though he may be possessed of a good machine, he may not be able to use it to the best advantage; and if he cannot put it in proper order, he will be obliged

bliged to bestow much unnecessary labour and time in charging his phials, &c.—but a little practice and attention will soon enable him to overcome every difficulty of this kind.

BUT he is not to expect that his machine will act equally well at all times. The *weather* has generally great influence on electrical experiments: When it is dry and clear, and particularly in frosty weather, they always succeed best; if it be rainy or damp, the electric matter will be attracted by the humidity of the air, and very little can be procured from the conductor. In this case, there should be a good fire in the room, to dry and warm all the glass materials,—we may then proceed without much interruption. But, on the other hand, if the weather be very dry and warm, the floor of the room and furniture, being without a proper degree of moisture, become very bad conductors, and little of the electric matter can be brought through them from the earth. Some kind of metallic conductor should now be fixed, so as to connect the rubber of the machine with the ground, or walls of the house. I generally make use of a brass chain, one end of which is fastened to the rubber, and the other end put through a small hole in the carpet on the floor, under which is sheet lead; by this means I generally collect as much of the electric fluid as I desire. But in very hot weather few experiments can be made to succeed properly, for though the glass may act tolerably well, no other than a small hissing spark can be taken from the conductor, and at a small distance;—in these circumstances, I own I know of no other remedy than *patience*, and if this be not at hand, I think the best way, for the present, will be to lay the machine, &c. wholly aside.

I MUST yet add another caution or two, which, though they may appear trivial, may not be altogether un-

unnecessary to those who are entering upon electricity. After the machine and apparatus have been used, they are not to be carelessly laid aside in any place, nor left exposed to the air; but should either be put up in a box, or covered over with a cloth, to preserve them from the moist air, and dust. The axes of the cylinder, &c. should be now and then fresh oiled:—All the *glass* materials, particularly, kept perfectly clean and dry, and these *banded* as little as possible.—If any conducting substance be near the machine, when working, it generally receives a part of the electric matter, and carries it off; it is therefore proper to remove every thing, that is not immediately wanted, to a distance. The flame of a candle, near the cylinder, or any part of the conductor, effectually takes off the electricity, and spoils the operation.

S E C T. III.

Remarks, and general AXIOMS in ELECTRICITY.

AN ELECTRICIAN should divest himself of *fear*, though not of *caution*. There is no possible danger in any electrical experiments, except in the charging of large jars and *batteries*; nor need he be under any apprehension from these, while he is careful not to touch any part of the conductor, or the wires leading to the inside of the jars. But I know it to be not unusual for persons, who are but little acquainted with the nature of electricity, to testify evident marks of fear, upon their approaching an electrical machine. Some can scarcely be prevailed on to receive the slightest discharge from the phial, or even to take a spark from the conductor, though they see others before them experience both, without the least inconvenience.

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This want of resolution might be excusable in women and children, but I own I cannot help smiling at the timidity of a man who can express any apprehensions of a momentary smart,—of a pain which is rather imaginary than real, as it can seldom be of half a second's duration; and I never knew it to be attended with the least disagreeable consequence.

THE mind is, perhaps, as readily susceptible of the *fear* of pain, as the body is of pain itself; hence our ideas of that which we have heard from the report of others, to be in any degree painful, seem to be magnified far beyond reality. When the force of condensed electricity was first accidentally experienced by Mr. CUNEUS, and afterwards by Professor MUSHENBROECK, Mr. ALAMAND, and some others, at *Leyden*, about the year 1726, the very exaggerated accounts those gentlemen gave of it, could proceed only from the surprise and terror they were thrown into by so extraordinary an event; for the experiment, it seems, was made with only a common phial, with water in it. Were not we able to repeat the same experiment, and in a manner much more forcible than they could perform it, we should undoubtedly, entertain far more tremendous ideas of it than what it really is. Though the Professor was struck with so terrible a panic that he declared, “he would not take a second shock for the kingdom of France,” yet we find that a shock ten times as great, may be received without injury.* There being generally in the human frame, so little resistance to a free passage of this subtle fluid, that the quantity

* Dr. PRIESTLEY, in his History of Electricity, says, “I once inadvertently received the full charge of two jars, each containing three square feet of coated glass. The stroke could not be called painful; but, though it passed through my arms and breast only, it seemed to affect every part of my body alike. The only inconvenience I felt from it, was a lassitude, which went off in about two hours.”

tity compressed in a common phial (usually less than a square foot of coated glass) can be attended with no other inconvenience than giving the inadvertent operator a transient disagreeable sensation.

A DILIGENT attention, however, is required, when he has occasion to use a considerable force. He should be pretty well acquainted, not only with the course which the fluid will take, in different dispositions of the apparatus, but also with the qualities of different conducting or non-conducting substances, which he may have occasion to use in diversifying his experiments. He would also do well in providing himself with an *Electrometer*, for determining the power and quantity of the charge, before the explosion is made.^f The force contained in a great number of coated phials (usually called an *Electrical Battery*) is very considerable; perhaps the matter condensed on a hundred square feet of coated glass, would acquire a degree of force sufficient to strike a man instantly dead: But they are seldom made, or required to be so large as this.

I AM sensible that to the *Electrician*, the preceding observations, and indeed most of the subsequent, will be unnecessary; but, perhaps, he may recollect the time when he would have been glad of them,—when the knowledge of a few plain rules and maxims would have saved him much labour and expence; but, (to use the words of Dr. PRIESTLEY) “it is hoped he will
“not envy others acquiring knowledge cheaper than
“he did himself. It is for the interest of the science
“in general, that every thing be made as easy and
“inviting as possible to beginners. It is this circumstance only that can increase the number of electricians,

^f The best kind of Electrometers for this purpose, that I have seen, is that invented by Mr. HENLEY, of *London*; and sold by Mr. NAIRNE, in *Cornhill*.

“ cians, and it is from the increase of this number,
 “ that we may most reasonably expect improvements
 “ in the science.”

It was chiefly with a motive of inviting others into this ample field of enquiry, in which I own I have frequently taken most agreeable excursions, that I have attempted to open a view of some of the most striking appearances which seem to be worthy of the enquirer's attention; in the pursuit of which, he may avoid others that have been found to be illusive; and, by striking a little out of the usual track, I have endeavoured to vary the common experiments, usually exhibited merely for amusement, so as to render them, at the same time, collateral proofs of such propositions as are necessary to be kept in view:—The most material are the following; which, as they are leading principles that are easily demonstrable, may be called

AXIOMS in ELECTRICITY.

1. WE say a body is electrified *positively*, or *plus*, when it has received *more* than its natural quantity of the electric matter: And

2. WHEN the natural quantity is *less*, or diminished, in a body, it is said to be electrified *negatively*, or *minus*.

3. ALL bodies in contact with the prime conductor of a machine, will be electrified *positively*, or contain a redundancy of the electric matter.

4. IF the rubber of the machine be *insulated*, and, at the same time, a chain, or other non electric, be hung to the prime conductor, so as to convey the matter to the ground, the rubber, and all bodies connected with it, will become electrified *negatively*.

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5. WHEN

5. WHEN two, or more, bodies are electrified *positively*, they *repel* or avoid each other.

6. WHEN two, or more, bodies are electrified *negatively*, they likewise *repel*; but

7. WHEN one body is electrified positively, and another negatively, they strongly *attract*:—And

8. ANY body electrified either negatively or positively, will attract another body that is supposed to remain in its *natural state*, or unelectrified;—there appears, indeed, to be a mutual attraction between both:—But, strictly speaking, no body that approaches another which is electrified, remains absolutely in its natural state, or unelectrified, because

9. “ ALL bodies that are brought within the influence of electrified bodies, (whether they are so by having *more* or *less* than their natural share of the electric fluid) become possessed of a contrary electricity.”

10. ON presenting the wire, which communicates with the inside of a coated phial, to the prime conductor, the inside of that phial will be electrified *positively*, and the matter become condensed on the *inside* coating to a great degree,—at the same time that the *outside* coating will become, in the same degree, *negatively* electrified.——On the contrary, if the phial be held in the hand by the wire, and the external coating be presented to the prime conductor, the inside of that phial will become electrified *negatively*, and the outside *positively*.

11. THINGS being in the situation as mentioned in Ax. 4. on presenting the phial to the rubber (or to a conductor in contact with it) its electricity will be directly reversed—If the *wire* be held to the rubber, the inside of the phial will be electrified *negatively*, and the outside

outside *positively*;—If the *outward coating* be presented, the inside will be *positive*, and the outside *negative*.

12. POINTS, or pointed bodies, (as the sharp end of a wire, needle, &c.) have a peculiarly powerful effect, both in *receiving* and *throwing off* the electric matter from any body electrified.

13. A globe, cylinder, or tube of glass made *rough* on the surface, will produce a *negative* electricity, if the friction be made with a *smooth* rubber; as will likewise a cylinder of *sealing-wax*, or of *sulphur*,—contrary to that of smooth glass, which always throws out a *positive* or *plus* electricity.

SECT. IV.

A Series of introductory EXPERIMENTS.

ELECTRICITY seems to demand a more *practical attention*, in order to investigate its properties with satisfaction, than perhaps any other science: Nor is it easy to convey an adequate idea of its surprising effects, without the help of *experiments*. If a person has once or twice seen a few of these, and attentively observed the mode and result of each operation, he will have a much clearer conception of electricity in general, and the use of the various apparatus, than any verbal directions can convey; but such directions, when the machine is at hand, have a tendency to facilitate the practice, and may possibly bring to the recollection, some appearances which might have been but slightly noticed, though necessary to be well understood, in order to pursue the science with success.

For this purpose I have endeavoured to select such experiments as are not only entertaining, but illustrative

tive of the preceding propositions.—The first that naturally presents itself is

Drawing the ELECTRIC SPARK.

EXP. 1. THIS is performed merely by presenting a knuckle of the hand, the knob of a discharging rod, or any other non-electric, within about an inch of the prime conductor, from which electric sparks, in the appearance of fire, will be seen to dart, attended with small explosions, and will be felt by the hand like a stroke given with the end of a small wire.

EXP. 2. IF the knob of the discharging rod be applied near the end of the conductor, or near to the glass stand that supports it, a much longer spark may be drawn, than from the middle; and it will be seen to form several curves in its passage, having the exact appearance of a flash of lightning.

WHEN any body, in its natural state approaches another that is electrified, (as in the above experiments) the condensed matter in the electrified body repels the natural quantity from the body unelectrified,*—from the surface nearest in contact, to its remoter parts, by which means that surface becomes electrified *negatively*, or in a state proper to receive a spark from the body which is over-charged with the matter, till, upon a nearer approach, it receives from the other all the compress'd fluid, in one explosion, which is instantly conveyed to the earth through the person who drew the spark.

I APPREHEND the violence of this attraction to proceed from two causes,—the repulsion of the electric particles to each other, and their attraction to the particles of matter. The dense fluid, in a body strongly elec-

* See Ax. 9. This will be proved in a subsequent experiment.

electrified, must necessarily repel that which is more rare, in the body unelectrified, and remove it to a distance adequate to the elastic force acquired by the former; by which means, that part of the unelectrified body which is nearest to the other, becomes a kind of *vacuum*, as attractive of the particles condensed on the electrified body, as they are repulsive of themselves.

ON the approach of a body in its natural state to one that is electrified *negatively*, the same effects ensue as in the former case, but from a cause just the reverse: The surface of the approaching body now becomes electrified positively, the fluid being drawn from its remoter parts, towards the body negatively electrified; hence there will be a strong attraction between them, for the reason before-mentioned, till, on a nearer approach, a spark proceeds from the former to the latter, which restores the equilibrium as before.

HENCE likewise the reason is evident, why two bodies that are both equally electrified, either negatively or positively, will never receive a spark one from the other, the repulsion being equally exerted in both.

EXP. 3. If a person be insulated, by standing on a board with glass supporters, and presents his knuckle to the electrified conductor, (the motion of the machine being stopped at that time) he will take only part, though the greatest part, of the fluid from it; the whole charge being divided between them, proportionably to their quantity of surface, and both the person and the conductor will afterwards give a small spark to another body presented.

EXP. 4. If a piece of metal, or a conductor, of the same size as that which is electrified, be insulated and presented to it, the electricity will be equally divided between them, and both of them will afterwards produce a spark equally strong.

EXP.

EXP. 5. The larger the conductor is, the greater will be the quantity of matter compressed on it, and of consequence the stronger will be the spark that may be taken from it: Therefore, if a person standing on the board before-mentioned, holds in his hand a wire or chain communicating with the electrified conductor, he may be considered as a part of it, and a much stronger spark may be drawn from him, by another person on the floor, than could be done from the conductor alone; and both will be equally sensible of the force of it.

EXP. 6. LET the person standing on the board, hold in his hand a spoon with a little brandy, or spirit of wine in it, (first warmed over a fire) and another person on the floor, apply his knuckle, or the end of a discharging rod, quickly towards the surface of it, and it will instantly be in a flame: the same may be done, if the person on the floor holds the spoon,—the spirit may then be fired by the electrified person.

EXP. 7. THE above experiment may be agreeably varied in the following manner;—The electrified person on the board holding the spirits, as before, let a person standing on another insulated board, or on a cake of wax, hold in his hand an iron poker, one end of which is made red hot; he may then apply the hot end to the spirits, and even immerse it in them, but they will not take fire; but, if he puts one foot on the floor, he may then set the spirits on fire with either the cold end or the hot, provided the latter be not worn to too sharp a point. An iron rod, with a knob at each end, is most proper for this purpose.

THE reason why the spirits could not be kindled by the person when insulated, is because the electric fluid cannot escape through him to the earth, he is therefore incapable of drawing a spark sufficiently strong to inflame them; and hot iron immersed in spirits, will seldom

dom or never set them on fire. When they are in-kindled by the electric spark, it is undoubtedly effected by the rapid and violent action of the fluid, in its passage from the surface of the spirits, through the inflammable vapour arising from it. A candle that is newly blown out, may also be rekindled by a strong electric spark, (every electric explosion displacing a quantity of air around it)—but this may be perform'd much easier by a breath of air from the mouth.

EXP. 8. TAKE an iron poker, or a bar of any metal, and make it red hot in the middle; let one end rest on the prime conductor, while the other is supported by a glass stand; in these circumstances an electric spark may be drawn from any part of the poker, from the ignited place as well as from the two ends. A *magnet* may also, at the same time, be hung to the poker,—it will attract, and be attracted by the iron, the same as though it was not electrified. This may shew that *magnetism* is not affected by *electricity*, nor *electricity* by *fire*; neither does it appear that the last is any way concerned in these operations.

S E C T. V.

Of Electrical Attraction and Repulsion.

THESE appearances have been subject to the enquiries of very learned and ingenious men. We find the names of BOYLE, HALES, HAWKESBEE, FRANKLIN, CANTON, among many others, of our own countrymen; and of ÆPINUS, BECCARIA, NOLLET, WILCKE, with other ingenious foreigners, to whose laborious researches and fortunate discoveries the world will ever remain indebted, and which have rendered their

their names illustrious in the annals of science. Most of them espoused their favourite *Theories*, which, in some points, widely differed from each other; but this was one reason that the progress of electricity, when those gentlemen were earnestly engaged in examining and correcting each other's *hypotheses*, appeared to be so rapid.

THE electricians in *England, France, Germany*, and other parts of Europe, and in America, imparted their discoveries to each other with a freedom that did honour to the advocates of science. TRUTH, more or less clear, is generally the result of a liberal enquiry. Accordingly several facts were discovered that were truly amazing, and which afterwards astonished the greatest part of Europe, where they were exhibited; every one being eager to behold experiments that appeared to be rather a kind of *magic* than the result of philosophy.

THE ELECTRICIANS themselves seemed to be somewhat puzzled in attempting to account for the appearances of *electrical attraction and repulsion*;—and it must be owned that they have not here been quite so fortunate in their elucidations, as to free the subject entirely from obscurity: In some instances, indeed, demonstration can scarcely be expected, and where we cannot be admitted to absolute proof, we must be satisfied with such conclusions as appear to be most rational and consistent.

OF all the opinions that have been hitherto adopted, concerning electricity, that of Dr. FRANKLIN, before recited, appears to have obtained the most general assent; not only because it is acknowledged to be the most probable, but because it may be extended to every electrical phenomenon, and is capable of solving every appearance, that admits of solution, in a
more

more satisfactory manner than any other : So that, like the *Newtonian PHILOSOPHY*, it now almost ceases to be merely an *hypothesis*.

EVERY one who has been conversant with electricity, will acknowledge that there are some appearances in this species of attraction and repulsion, which are not readily and precisely to be accounted for, from the postulata of any of the received *theories* of electricity. But, in attempting to account for *any* appearance, it is necessary that *some* theory should be kept in view, or we are not likely to draw many satisfactory conclusions : And it is certain, that those inferences have hitherto been liable to the fewest objections, that have been drawn from the principles of Dr. FRANKLIN.

EXP. 1. TAKE ten or a dozen small downy feathers, and tie each of them separately to a fine linen thread ; let the whole be then tied to the end of a small metal rod. The length of the rod is of no consequence,—the threads may be about an inch and half in length. If the end of the rod be inserted into the prime conductor, upon setting the machine in motion, the feathers will immediately expand, and, avoiding each other, will stand at the greatest possible distance. The feathers receiving from the conductor a greater quantity of the electric matter than is natural to them, their *atmospheres* (as it is sometimes called, tho' perhaps improperly) repel each other.^b At the same time, if the hand, or any other non-electric, be made to approach them, they will all be strongly attracted to it.ⁱ The hand being in its natural state, or rather, acquiring a small degree of a contrary electricity, attracts, and is attracted by the abounding quantity of matter in the feathers.

EXP. 2. IF the feathers be connected to a conductor electrified *negatively*, the same appearances will ensue

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as

^b Ax. 5. ⁱ Ax. 8.

as in the foregoing experiment. The feathers will appear to be repelled from each other,^k and attracted by any other body.

WE cannot so easily conceive why two bodies that are *negatively* electrified should repel each other, as we can when they are electrified *positively*. It is supposed that, 'when two or more bodies are exhausted of their natural share of electricity, they are attracted by the denser fluid, existing either in the atmosphere contiguous to them, or in other neighbouring bodies; which occasions them still to recede from one another, as much as when they were overcharged.' Others have supposed it to be rather owing to 'an accumulation of the electric fluid on the surfaces of the bodies; which accumulation is produced by the attraction of the bodies, and the difficulty the fluid finds in entering them. This difficulty in entering is supposed to be owing, chiefly, to the *air* on the surface of bodies, which is probably a little condensed there.'

PERHAPS the apparent *repulsion* of bodies electrified either *negatively* or *positively*, is occasioned rather by the attraction of other bodies surrounding them, and the humidity of the *air*, than by the repulsion of any electric *atmospheres* that may surround the electrified bodies. I am the rather of this opinion from the following observations—When the feathers, before-mentioned, are placed in the middle of a large electrified surface, such as a board three feet square, their repulsion of each other will appear very languid, to what it will if they are placed at the *edge* of the board, so as to be more immediately within the attraction of un-electrified bodies. If a single feather, or a piece of down, be placed near the edge of the board, it will immediately fly off to the nearest body that is un-electrified; but, if placed in the middle of the board, it will

^k Ax. 6.

will be a considerable time before it will move, and scarcely shew any signs of repulsion till another body be held over it, the feather will then immediately fly to it.—When the bunch of feathers is set up on the board, and covered with a large glass recipient, they will hardly be repelled at all, or, if they are, they soon collapse; when the recipient becomes a little electrified, a spark taken from the prime conductor will make the feathers expand, being attracted by the electricity of the glass.—If an *air-pump* be placed on the electrified board, and the rod of feathers set up in the exhausted recipient, I never found them to shew any signs of electricity, till the hand, or some other body, approached the glass, they would then be attracted to it. The effects will be the same, in these experiments, whether the electricity be positive or negative.

EXP. 3. THE feathers being expanded with either electricity, if a pointed wire, or a pin be presented towards them, it immediately makes them collapse and shrink together; the point drawing off the electric matter, they become unelectrified, and are therefore suddenly attracted by the electricity of the conductor. If the point be presented to any part of the conductor, the effect will be nearly the same.

EXP. 4. LET the pointed wire, instead of being held in the hand, be fixed to any part of the conductor, with the point outward; upon turning the machine, the feathers will be electrified but very feebly, rising gradually, as though the quantity of electric matter was very small; the point throwing most of it off into the air.¹ If the feathers are fixed to the *negative* conductor, the effects will be the same, but the cause reversed.

EXP. 5. LET two very small balls of cork be fastened to the ends of two threads, about six inches in length.

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¹ Ax. 12.

length. If these be held in the hand near the electrified conductor, they will be strongly attracted to it, and repelled from each other. The electricity of the conductor repelling the natural quantity from the balls, through the threads, to the hand that holds them, they become *negatively* electrified, and therefore avoid each other, at the same time that they are attracted by the *positive* electricity of the conductor. But, if the balls are held towards a conductor *negatively* electrified, they will diverge with *positive* electricity, this being drawn from the hand, through the threads, to the balls.

EXP. 6. LET a circle or hoop be made of thick brass wire, 12 or 14 Inches diameter, to which tie 6 or 8 fine threads, at equal distances from each other. Let the same number of threads be fastened to another smaller hoop, of a size just fitting the prime conductor, so as to go on the end of it. The threads are all to be of an equal length, and of such a length as, when the smaller hoop is placed in the centre of the larger, and the threads from each extended toward one another, their ends may reach each other within a quarter of an inch, forming so many diameters to the hoop, like the spokes of a wheel.—Put the small hoop on the end of the conductor, and, when the machine is in motion, the threads will all be extended in right lines. If the larger hoop be then vertically fixed on a glass stand (with a chain hanging from it to the table) so as to form a circumference to the other, the threads on both will be attracted, and the ends point to, and nearly meet each other.

THIS experiment has been admired as curious, but is readily accounted for, on the theory of Dr. FRANKLIN.—The threads on either hoop become possessed of an electricity contrary to each other; those on the small hoop have a *redundancy*^m of the electric matter, and those

^m The *positive* electricity is always supposed to be made use of, unless the contrary is mentioned.

those on the larger a *deficiency*;^a they are, consequently, strongly attracted to each other. The electric matter flies off from the threads of the small hoop, is received by those on the larger, from which it is conveyed, thro' the chain, down to the table, &c. If the chain be taken away, the larger hoop will be insulated—the threads on it will first be attracted as before, to those on the smaller, till becoming charged with a *positive* electricity, they will immediately be repelled, and avoid the others: Thus they may be made to attract or repel, at pleasure, by touching the large hoop with a non-electric.—This is an entertaining experiment, but requires some degree of attention to make it succeed properly;—the following is on the same principle, and is more easily managed.

EXP. 7. LET a single thread be suspended from the prime conductor, five or six inches long, under which let another thread, of the same length, be fastened to any thing on the table, so that the end of it, when extended, may nearly touch the end of the thread from the conductor. Upon turning the machine, the two threads will be attracted, and point to each other, as in the last experiment. If any non electric (as the round knob of a discharging rod) be made to approach the ends of the threads, when so attracted, it will repel the lower thread, and attract that which is connected with the conductor.

THE end of the discharging rod being electrified negatively by the upper thread, immediately attracts it, and, for the same reason, repels the lower thread, which is likewise in a negative state. But, if the end of the rod be brought to the *lower part* of the undermost thread, so as to be *out of the influence*, or atmosphere of the upper one, the under thread will be immediately attracted by the rod.

WE may have an agreeable proof of this *negative state* of the lower thread in the following manner,—

Take

^a Ax. 9.

Take a small coated phial, with a thick wire, communicating with the inside, fastened by a cork, in the neck of the phial; electrify the inside of it *negatively*;* if the wire of the phial be then brought near the ends of the threads, we shall find the effects to be the same as when the discharging rod was applied,—the upper thread will be attracted, and the lower one repelled. But, if the phial be electrified *positively* on the inside, and the wire brought to the threads as before, the appearances will now be directly contrary—the upper thread will be repelled, and the under one attracted.

EXP. 8. LET a discharging rod with a brass knob at each end, be fixed upon a glass stand, or some other electric, and one of the knobs be placed within an inch and a half of the prime conductor, the other, at the farthest possible distance from it: That end of the rod near the conductor will then be within the influence of its electricity, whereby the electric matter natural to the rod, will be repelled to the ~~other~~ ^{other end} end; so that one end will be electrified ~~negatively~~ ^{negatively} and ~~positively~~ ^{positively}.

IN order to prove this, Take the small coated phial, and, on the wire that communicates with the inside, fix a small downy feather. Charge the phial positively on the inside: The fibres of the feather will then expand, and be attracted or repelled according to the quality of the electricity that it approaches.^p Holding the phial by the coating, present the feather to any part of the prime conductor, and it will be repelled; if the feather be presented to that knob of the rod which is nearest to the conductor, it will be attracted to it; but, if it be brought to the other knob, it will be again repelled, as at the conductor, but not so strongly, because the electricity of the rod is not so strong. Change the electricity of the phial, and all the appearances will be changed; If it be electrified negatively on the inside, the prime conductor will attract the

* Ax. 11.

^p Ax. 5, 6.

the feather, as will likewise the knob of the rod that is remote from it, but the knob near the conductor will be found to repel the feather. This, and the preceding experiment, seem to be pretty clear proofs of the 9th axiom, which was a discovery first made, I believe, by the late ingenious Mr. CANTON, and afterwards illustrated in a variety of experiments by Dr. FRANKLIN, Mr. WILCKE, ÆPINUS, and others; on which principle many appearances of electrical attraction and repulsion are easily accounted for, which would otherwise be enveloped in obscurity.

EXP. 9. WHEN any substance is once electrified, and thoro'ly insulated by good electrics, that substance will not readily part with the electricity it has received, till it has touched some other body that is unelectrified. For this reason, if a light piece of cotton, or a downy feather be brought near an excited glass tube, it will first be attracted to it, till it be replete with the electric matter of the tube; being then electrified positively, it will recede from the tube, and be driven into the air, (where it may be said to be insulated, the air, when free from moisture, being a very perfect electric.) A person with the excited tube in his hand, may drive the feather about in what direction, or to what place he pleases, for it will still fly from the approaching tube, till it has lost all its redundant electricity; or two persons with each of them a tube, may drive it from one another like a shuttlecock. This experiment, if there be a little dexterity in the management of it, proves very amusing, and indeed, would appear very astonishing, but that the effects are always the same, and the cause sufficiently apprehended.

EXP. 10. THE strong tendency of electrified bodies to avoid each other, and to attract bodies unelectrified, is the immediate cause of all the diversity of appearances that we see in the various experiments of electrical

cal attraction and repulsion;—This may be simply represented in the following manner—Take a small cork ball, a piece of cotton, or any other light body, and tie it to the end of a silk line; suspend it about two inches from the side of the prime conductor, and hold the palm of the hand at the same distance from it, so that it may hang in the middle, between the hand and the conductor: If the machine be then worked, the ball will be attracted to the conductor, and, being immediately loaded with the electric matter, will as soon be repelled from it, or attracted by the hand, which, receiving from it its small quantity of electricity, it will then be attracted and repelled between the hand and the conductor with surprising rapidity.

EXP. 11. THE ringing of *electrical bells* is explained on the same principle.—Three small bells being hung to a rod of metal, about an inch distant from each other, the two at the ends by a brass chain, the middle one by silk—between each bell, a very small piece of metal, suspended also by silk, as clappers. These being hung to the conductor, the clappers will strike the bells very forcibly. The two outward bells, being suspended by chains, become electrified, and attract the clappers, these, receiving the electric matter, are immediately repelled from them, and attracted by the middle bell, whereon they discharge their electricity, which is conducted off to the ground, by means of a chain fixed to the bottom of that bell.

EXP. 12. LET a plate of metal, six or seven inches diameter, be suspended by wires, or chains, from the prime conductor—another plate, nearly the same size, placed about four inches below it, upon any conducting substance.—If feathers, pieces of paper, or any other light substances, are put on the under plate, they will be attracted and repelled from one plate to the other with prodigious swiftness. A piece of thin paper
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(or rather a bit of leaf gold) cut in the form of an acute angle, or sharp at one end, and wide at the other, will frequently be suspended, for a considerable time, between the two plates, without touching either.

A GREAT variety of other entertaining experiments may be performed by electrical attraction and repulsion, which, with a little invention, the young electrician may adapt to his own purpose or fancy; every variation, in these experiments, not only facilitates the *practical* part, but has also a tendency to render the *theory* more perspicuous.

SECT. VI.

*Experiments made by the Blast issuing from the POINTS of
ELECTRIFIED BODIES.*

FROM the sharp edges or points of bodies electrified either positively or negatively, there is always a sensible wind, occasioned, perhaps, by the precipitate retreat of the electrified particles of *air* near those points, where the electric matter is greatly condensed, both in its entrance and exit from them.

It is somewhat remarkable that this current of air is the same, whether the point be *imbibing* or *throwing off* the electric fluid. If a sharp-pointed wire be projected from a conductor, either positively or negatively electrified, it will sometimes blow a blast sufficient to extinguish a candle held before it, and equally strong from either electricity: Or, if the point be held in the hand, and presented to the conductor, it blows nearly the same;—if it be held opposite to another point on the conductor, they will both blow against each other, but the point in the hand not so strongly as that of the conductor.

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To a person possessed of a little ingenuity, or a turn for mechanics, it needs only be intimated, that there is a blast or current of air issuing from the points of wires, turned in any direction, and he will immediately perceive how great a variety of appearances and movements may be effected by means of this *primum mobile*: He will very soon find himself able to apply it to the purpose of turning small paper vanes, made in diverse forms, and to make these communicate motion to a variety of engines in miniature, &c.—but to be explicit in these effects of electricity, would be deviating too much from my present design, which is rather to promote its utility than its divertisement.

THE ingenious Mr. JAMES FERGUSON, whose invention is seldom at a loss in blending agreeable entertainment with philosophy, has invented and made a variety of little curious machines of this kind, whose movements are effected by the blast of air from electrified points. I must refer the reader to his book entitled, *An Introduction to Electricity* for a particular description of his *electrical orreries, clocks, water-mills, pumps, &c.* which will afford much entertainment to those who can relish innocent domestic amusement. The science of electricity, as well as many others, is undoubtedly indebted to this gentleman; for, to render any science familiar and agreeable, is to render it prevalent, and the more it prevails in practice, the more likely it is to produce useful discoveries.

I SHALL therefore just mention one or two experiments, which the electrician may vary and improve at his leisure.——When any points are electrified, so as to emit a strong blast, the re-action of the air forces them backward, or gives them a tendency to move in a contrary direction; so that if a small wire be bent at the ends, and each point be made to have a direction opposite to the other, and then nicely poised on the
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the point of another wire, on which it may freely turn, as a centre, when these wires are set up on the electrified conductor, the bent wire will be found to turn round like the fly of a jack—the points will also be illuminated, and, in the dark, will appear like a circle of fire.

WHEN I first saw this experiment, I was rather at a loss to determine whether the turning of the wire was effected merely by electricity, or by the re-action of the air on the points; I therefore electrified the wire *negatively*, supposing that, if electricity was the cause of it, as the fluid was now *entering* the points, the wire would either turn the contrary way, or else not turn at all; but, finding it turned just the same as it did before, I concluded it to be solely owing to the resistance of the air; but, in order to be farther satisfied, I fastened two small glass *eolipiles* to the ends of a light rod of wood, their orifices, which terminated in a capillary tube, in opposite directions to each other: Under the eolipiles were fixed two small lamps, and the whole suspended by a thread in the centre. When the lamps were lighted, and the eolipiles sufficiently heated to emit a current of air, the apparatus began to be in motion, and soon afterwards turned round pretty swiftly.

I ELECTRIFIED the wire fly in the exhausted receiver of an air-pump, but found it would not turn at all—and but very slowly, if covered with the receiver, without exhausting, unless the hand was made to touch the glass; it might then be made to turn by the electric attraction, in any direction, either with the points foremost or the contrary. But this operation, if it be continued for any time, will charge the glass recipient very strongly with the electric matter, and, if the hand be put into it, while the other is opposite to it on the outside of the glass, an explosion will frequently be produced, and the person receive a smart shock.

IF the wires are insulated, and placed near an electrified body, or even held in the hand, they will turn round very swiftly, but if they are placed near a glass cylinder in motion, they will be turned with so great rapidity as entirely to disappear, except in the dark, when a beautiful luminous ring will be visible.

IF small boats are made of cork or light wood, and floated on electrified water, they may be attracted and made to swim in any direction, by applying a finger towards them; a fine needle stuck into the end of the boats, in the manner of a bowsprit, will cause them to be repelled from the hand, held over it, and they may be steered by it, stern foremost, to what point of the compass you please. The boats might have the addition of sails to them, and might then be made to sail very briskly before an electrical gale, from the point of a wire held in the hand.

THE operator in these tricks, would certainly be looked upon as a magician, if the electrical machine was kept out of sight: But a still more striking appearance, would be a number of these boats, with each of them a twirling wire fly, about an inch in length, fixed to the top of the mast; the hand held over them, would set them all in motion, which, in the dark would appear as so many rings of fire, moving in various courses, and following the hand in any direction.

WHEN a few young persons have nothing else to do, they might very innocently amuse themselves by making a representation of a kind of sea-engagement between these boats—supposing each of them to be large enough to hold a small coated phial without sinking; these phials may be charged, some of them positively on the inside, others negatively; they may then be placed at the bow of the boat, with the wire (which should have a very small brass ball at the end of it) and

and the uncoated part of the phial, projecting over; a small brass chain should be made to touch the outward coating of the phial, and the other end brought over the stern of the boat, and hang so as to touch the water. The boats being then put into a trough of water, and the phials pretty highly charged, they will soon be in motion; those that are electrified alike, will repel each other, and those possessed of a contrary electricity will be attracted, till the balls of the two phials approach pretty near together, they will then discharge their contents with a loud explosion, and the boats afterwards sheer off from each other.

S E C T. VII.

Of Charging COATED GLASS.

WE are now to consider the electric fluid in a state of compression, in which it will appear to be a much more formidable agent, than in the preceding experiments.

It is well-known that *air*, when condensed, will act with a prodigious force. Upon turning the stop-cock of the vessel that contains it, it will rush out with a violence proportionable to the degree in which it was compressed. This force would be greatly increased if, (instead of the air discharging itself into the common atmosphere) upon turning the stop-cock, it was made to pass into a *vacuum*, or another vessel out of which the air had been exhausted. The air is supposed to acquire this spring, from the repulsive power of its particles, each repelling, or endeavouring to recede from the other; so that the more they are compressed, or forced closer together, the greater will be their resistive force.

force. The electric fluid is of a nature still more elastic than the air, and its particles more strongly repulsive of each other; for which reason, if a quantity of it be condensed on one side of a pane of glass, and, at the same time, the other side be equally exhausted, the efforts made by it to restore the equilibrium must be very considerable.

WE may pursue the parallel, by supposing the explosion of a charged glass phial (which is made by forming a communication from one side to the other, by means of conducting substances) to be similar to the turning of the stop-cock which separates the condensed air from the vacuum,—the effects of either, will be a rapid transition of the fluids to their natural situation.

NEITHER the form nor size of the glass is of any consequence, with respect to its becoming *charged* with the electric matter. A pane of common window-glass, with either leaf-gold, tinfoil, or any other non-electric substance, placed in contact with both its sides, is capable of being charged as well as a glass phial, or jar, provided a margin of the bare glass, at least an inch in breadth, be left all round it. Other electric substances, different from glass, are also capable of becoming charged, as a plate of *sealing-wax*, *sulphur*, *baked wood*, and even the *air*, acting as other electrics, will keep asunder, for some considerable time, the *plus* electricity from the *minus*.

IN order to charge a pane of coated glass, or a phial, we connect one side of it, by means of conducting substances, to the prime conductor, while the other side is connected with the earth. The electric matter then passing from the conductor to the *inside* of the glass, (supposing it to be a phial) electrifies that side positively, and, at the same time repels an equal quantity of the fluid from the *outside* of the glass, which is driven back to the earth; by this means, one side of

the glass becomes exhausted, and the other redundant, or, in other words, one side is electrified *negatively*, and the other *positively*.

A PHIAL will remain in this situation, when set upon electrics, for 12 or 24 hours, or perhaps, much longer, if the air be dry, and no conducting substance approaches it; but, if one end of a discharging rod be apply'd, first to the outside of the phial, and the other end brought to the wire that communicates with the inside, a strong explosion will immediately ensue, and the glass be instantly restored to its natural state. The person who makes the explosion in this manner, will not be affected, or in any measure sensible of the disagreeable sensation usually termed a *shock*, as the matter all passes through the discharging rod; but, if he applies the rod to the wire, or any part of the conductor in contact with it, before he touches the outside of the phial, he will receive a great part of its contents through him, and feel a sharp, pricking pain, as though he was cut with a keen instrument, and the phial will still remain partly charged. If the discharging rod, or the hand, be brought to the wire of the phial, while the other hand touches the outward coating, all the matter will pass through the person's arms and breast, and he will be sensible of a smart shock. A chain being fixed to the outward coating of the phial, and the other end of it made to touch the floor, a person setting his foot on this chain, and then applying his hand to the conductor, he would be sensible of the shock both in his hand and foot, and, if it be a very large phial, all over his body; the fluid passing entirely through him, from the conductor, up the chain, to the outside of the phial.

If a charged phial be set upon electric substances, it may be taken hold of, without danger, either by the coating or the wire; no more than a small spark will
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issue from one or the other; in this manner, by alternately touching the wire and outside, it may be totally discharged without any explosion.

IN the discharge of a phial, the electric matter is always found to pass through the best conductors, more readily than through conductors that are less perfect, though the circuit, in the former case, may be much longer. It will go through a hundred yards of wire, or chain, rather than through half as many inches of wetted packthread, (supposing the discharge to be made through both at the same time) a small quantity of the fluid, however, would be found to pass through the packthread.

IF the discharge be made through conductors equally perfect, but of unequal lengths, the greatest part of the fluid will pass through the shortest; as, supposing the explosion to be made through two different circuits, one of them formed by two persons, joining hands, the other by a person singly—they would all feel the transition of the fluid, but the two, not so violent as the single person.

IF a circuit be formed by any number of persons joining hands, on the discharge of the phial they will be all shocked with equal violence, and at the same instant of time; but the violence of the shock to each person, will not be so great, supposing them to be twenty or more in number, as it would if there were only three or four.

EXP. I. TAKE a small coated phial, with a hook to the wire that communicates with the inside, and suspend it on some part of the prime conductor, (for which purpose, and for several others, it is convenient that the conductor be furnished with some brass rings) though the machine may act very strongly, yet the phial, in this situation, cannot be charged; the reason
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of which is, 'because little or none of the electric matter can escape from the outward coating, and therefore no more can be thrown into the inside than that which is equally condensed on the conductor. But the outside of the phial will be found to be electrified, and will yield a spark to any non-electric that approaches it; if sparks are repeatedly drawn from it, the phial will become charged; as much of the electric matter as is taken from the coating, so much will be compressed on the inside, till the phial is fully charged.

If a sharp-pointed wire be fixed on, and made to project from the coating, it will carry off the fluid from it, and the phial will become charged; or, if a point be held at the distance of three or four inches from the phial, it will likewise charge, the point, in this case, imbibing the fluid from it.

As the phial cannot become *charged*, unless the electric matter be conveyed from one side by means of conducting substances, at the same time that the other is receiving an equal quantity, so likewise it cannot be made to *explode*, but by means of metallic, or some other good conductors, forming a channel conveyance from one side to the other; for, as the fluid cannot pass through the glass,^a on account of its being a non-conductor, one side must therefore remain exhausted, in the same proportion as the other side is redundant, notwithstanding the power of attraction between them is so very great, and having no other *barrier*, to separate

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^a It has been objected that, if the glass be supposed to be impermeable to the electric fluid, there arises a difficulty in conceiving the manner in which it exerts its attractive and repulsive powers through the glass. This *impermeability*, if we conceive it to be no more than a *resistance* of the fluid's passage, is not peculiar to *glass*, it is common to all other electric substances, which resist the passage of the fluid in proportion to their quality of being more or less perfect: But it is certain that
this

rate them, than the thin substance of the glass. This *thinness* of the glass is, indeed, the cause of the attraction being so strong, as it admits of the most affecting proximity, without an absolute contact. For this reason, the thinner a phial is blowed, in the making, the higher will be the charge it is capable of receiving; but it will be so much the more subject to a spontaneous explosion; if it be too thin, the force of a strong charge will frequently break the glass, perforating a small hole, and sometimes two or three, through the glass and coatings; the glass appearing to be pulverized, a considerable space round the hole.

EXP. 2. TAKE two small coated phials, and charge them *positively*, on the inside; let them be suspended, by their hooks, to the prime conductor: The discharging rod may then be applied to the outward coating of each of them, so as to form a communication, but there will be no explosion; the coating of both being electrified in the same manner, [*negatively*] neither of them has any thing to communicate to the other. The phials may be taken off the conductor, and the wires of each brought together, with no more effect than before; but, was a person to hold one of the phials by the wire, and the other by the coating, and bring the coating of the one to the wire of the other, there would immediately be an explosion, and the person would be sensible that the charge of both had passed through him.—If one of the phials was to be electrified *positively*

this resistance, even in the most perfect electrics that we know of, is not sufficient to prevent the attractive influence, or effect of the fluid upon bodies brought to a certain degree of vicinity; and it is as clear, that this action of the fluid, whatever be the cause, is not effected by its *passage through* the electric. It is, perhaps, as difficult to form a perfect idea of the mode of action which, in this instance, seems peculiar to the electric fluid, as it is to conceive the primary cause of gravitation, magnetism, or any other species of attraction and repulsion.

tively, and the other negatively, both being suspended to the conductor, and the discharging rod applied as before, to the outside of each, the electric matter would rush with violence from one to the other, through the rod, and both the phials be discharged.

EXP. 3. A PERSON standing on the glass-legg'd board, before mentioned, (when connected with the prime conductor, by means of a chain, or metal rod) and holding in his hand a small phial, if he presents the wire of it to another person, standing on the floor, the phial will become negatively charged on the inside, the fluid having passed from thence to the earth, through the person who stood on the floor; let the phial be then delivered into the hand of the person on the floor, who, taking hold of it by the coating, may present the wire to him on the board; by this means there will be thrown into the inside of the phial, a quantity of the fluid sufficient to restore the equilibrium, and, if the motion of the machine be stopped in proper time, the phial will be found to be in its natural state, or entirely discharged, without any explosion.— This experiment may be performed by one person, who, holding the phial by the wire, may present the outward coating to the conductor, by which means the phial will become charged as before, viz. negatively within, and positively without; when it is charged, let him set it down on glass, or some other electric; and, taking hold of it by the coating, present the wire to the conductor, and the phial will be gradually discharged:—Or, if the rubber of the machine be insulated, he may present the wire of the phial to the conductor (counting the number of revolutions of the wheel) till it be charged; then, holding the wire to the rubber, the same number of revolutions will discharge the phial.

THESE experiments may be varied many ways, by electrifying the phials, sometimes positively, and then negatively, both at the prime conductor and at the rubber, or negative conductor; by which means any one may very soon perfect himself in the theory and nature of electric circuits.

EXP. 4. TAKE a common phial bottle, thoroughly dry, and fill it about two thirds full of quicksilver, steel-filings, or leaden-shot; let a wire be then inserted into the neck of the phial, so as to touch the shot; if the lower part of the phial be grasped in the hands all round, and, at the same time, the wire applied to the electrified conductor, the glass will become charged, and capable of conveying an explosion or shock, the same as though it was coated: The shot may be poured out of the phial; but though it be poured into a glass vessel, it will shew little or no signs of electricity; nevertheless, the phial will still remain strongly charged:—In order to prove this, pour the shot into it again, and grasp the lower part of the phial as before, then, upon inserting the wire into it, a convincing proof will follow. This evidently shews, that the force of a charged phial is not contained in the non-electric coating, but in the glass itself. It is surprising to find how large a quantity of the electric matter is capable of being compressed in a small quantity of glass; an ounce phial, blown very thin, may be made to contain a charge as strong as a man can well bear.

THE force of an electric explosion seems to depend more on the height of the charge, or degree in which the fluid is compressed, than on the quantity of it. A quart phial, when fully charged, will act nearly with as great force as a phial containing a gallon, when no more than half charged: The explosion will likewise be as loud, and the sensation or shock, more smart and pungent. Several reasons might be assigned for this;

this ; the chief cause, perhaps, is the fluid being much less condensed, in proportion to its quantity, it cannot acquire so great a spring, or elastic force, and, possibly, its velocity is also diminished in a certain ratio : A large phial must be blown thicker, in the making, than a small one, whereby the power of the charge will be decreased.

NEARLY double the electric force may be obtained from four phials, containing a quart each, as from one gallon phial ; not only from their being more thin, but because they be made to contain a much greater quantity of coated surface. The *bottom* of a phial, though coated, by reason of the thickness of the glass in that part, adds very little to the strength of the charge, and therefore should not be included in calculating the quantity of coating.

IN charging of phials, much depends on the goodness of the machine, and the force with which it acts. Every machine has a certain degree of force, and is capable of fully charging a certain number of phials, which has been properly called the *maximum* of its power, beyond which it cannot go, though the motion be continued. If the number of phials exceeds the power of the machine, they will never be fully charged. The greater is the quantity of fluid compressed in a phial, the greater will be its resistance of receiving more : so that when the resistance becomes equal to the power of the machine, the fluid will have as strong a tendency to fly off from the pointed wires that collect it, as the cylinder of the machine has to throw it on. For this reason, if a machine be capable of fully charging no more than two phials, though twenty be connected with it, they will produce no stronger an explosion than the two.

EXP. 5. A VERY curious experiment, in order to shew the nature of charging electric substances, may
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be made with a pane of glass, about a foot square, coated on each side with tinfoil, within two inches of the edge. But a form more convenient for holding in the hand, would be a circular piece of glass, with a kind of handle, in the form of a battledore.—Two small wires, about two inches in length, may be made to project from the centre of the coating, one on each side—they may be easily fixed on with sealing-wax; so that one end of the wire may touch the tinfoil. By this instrument, the direction or course of the electric fluid, as the glass is charging, may be rendered visibly evident, in a dark room. If the machine acts pretty strongly, upon holding the glass in the hand, and applying the end of one of the wires within half an inch of the end of the prime conductor, that end of the wire will be illuminated with a small star, or speck of light, the same as is seen on the points of those wires that collect the fluid from the cylinder, which is always a mark of their *receiving* the electric matter; at the same time, a pencil of diverging rays will be seen to issue from the opposite wire, on the other side of the glass, especially if the hand, or other non-electric, be held within a few inches of it; this is also as evident a sign, that that wire is *throwing off* the fluid.

WHEN the glass is fully charged, (which may be easily known by the flashes of light, that will appear round the edges of it,) change the side, turning that wire from the conductor which, before, was towards it; that side of the glass which *wants* the fluid, will now be toward the conductor, and the side which is redundant, turned from it; the consequence of which will be a much more violent *afflux* and *efflux* than before. It is really surprising to see with what eagerness and rapidity the point near the conductor receives the fluid, and the other carries it off, to any conducting substance that may be near it: ~~But~~ the operation, respecting the glass, is now just the contrary to what
it

it was before—it was then *charging*, it is now *discharging*; and, if taken away from the conductor in proper time, it will be found to contain no charge at all; but, if continued longer, it will begin to charge again as before.

If this glass be held, in the same manner, to a *negative* conductor, the appearances will be just the reverse,—the point toward the conductor will now throw out the diverging rays, and the other point be illuminated with the star. If it be charged, in this manner, at one conductor, and the same point immediately applied to the other, the glass will discharge as when the contrary point was turned to the same conductor.

WHEN the glass is fully charged, as often as that wire, which is on the side negatively electrified, be touched with a non-electric, the opposite wire will throw out a diverging flame; but, if the positive wire be touched, the other will have only an illuminated point.——In these experiments, the ends of the wires should not be reduced to too sharp a point, but left as they are cut off with a pair of nippers.

If a pane of glass be coated with emboss'd gilt paper, instead of tinfoil, it will exhibit a very curious appearance in the charging of it; the sparks of electric light will be seen on various parts of the paper, of different colours; and, if the explosion be made by means of a chain, the glass will appear covered with fire on both sides.

AFTER a large phial has been discharged, and particularly when more than one is made use of, there will still be a *residuum*, or small quantity of the fluid remaining in it, which descends from the uncoated part of the glass; it may therefore be proper to apply the discharging rod to it a second time, after the explosion is made, before it be touched with the hand:
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Much mischief has frequently been done to an electrical apparatus, by a person's receiving a small shock unexpectedly, which causes so sudden a contraction of the muscles, that the glasses, &c. are sometimes struck down.

THERE are instruments, very convenient for discharging of jars and phials, called *Electrometers*—they are made in different forms, but the best I know of, is that which fixes horizontally to the top of the phial: The metallic part of this instrument, which acts as a discharging rod, may be placed at any distance from the wire of the phial; by which means the explosions will be made without farther application, always of an equal degree of force, and this greater or less, as may be required: It is particularly useful in electrifying a person for any complaint.





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E S S A Y

On ELECTRICITY, &c.

P A R T II.

MEDICAL ELECTRICITY. *General Observations on the Electric Fluid, considered as a MEDICINE, with the Sentiments of different Writers on the Subject. Directions for its Application; and a Collection of various Cases and Cures, indicating the Disorders which seem most likely to yield to Electrical Treatment.*

S E C T. I.

Of the Medical Effects of Electricity.

THE electric fluid seems to be replete with so many extraordinary and remarkable properties, that it is impossible to say, what great and beneficial discoveries may not hereafter arise from a practical enquiry into its nature and effects. If we consider it in one interesting point of view, it appears to be an object truly worthy of attention—I mean, the use that has been made of it in curing, or facilitating the cure, of a variety of disorders in the animal system. That electricity has effected such cures, is, I think, beyond
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dispute ; it therefore only remains to enquire into the most eligible method of extending its utility.

THE discovery of *medical electricity*, like that of the *Leyden phial*, appears to have risen rather from accident, than from any reasoning on the subject *a priori*. Some remarkable cures having been, in a manner, casually effected by electricity, more than twenty years ago, the novelty of so extraordinary a medicine, excited the curiosity of great numbers of people : The result of which was, what might naturally have been expected to arise from a too superficial examination—some treated it as a mere chimera, and, either from caprice or design, endeavoured to explode its use ; while others seemed to be in expectation of an absolute *panacea*, and perhaps, with as little reason, bestowed on it the most extravagant encomiums. Electricity, however, gained ground, being made use of by great numbers, and, by some means or other, was most frequently attended with success.

It was not to be expected that a science which, even at this day, may be said to appear only in its dawning rays, should, in a few years, be investigated with that degree of precision which is necessary either to establish a *theory*, or to determine an exact mode of practice ; but it is much to be regretted, that the practice has so long been confined chiefly to such persons, whose investigations have been insufficient to establish a theory. Men of genius and literature have hitherto viewed the subject of electricity in a philosophical light, much more than in a medical one. It is, indeed, with pleasure that I now find there are some gentlemen of abilities and discernment, to whose province it more immediately belongs, that are disposed to extend their enquiries into its efficacy as a medicine ; because it is from these only, that we are to expect any consummate rules for its application, which must be founded on reason and experience.

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A WRITER on the subject, a few years since, gave it as his opinion, that the electrical method of treating disorders cannot be expected to arrive at any considerable degree of perfection, till administered and apply'd by gentlemen of the faculty——“ Nay, “ then, says he, all my hopes are at an end; for when “ will it be administered and apply'd by them?—Not “ till they have more regard to the interest of their “ neighbours than their own; at least, not till there “ are no *apothecaries* in the land, or till physicians are “ independent of them.” I own I cannot entirely agree to this writer's conclusion; I had much rather believe there are many gentlemen of the faculty who, merely from a principle of benevolence, would heartily concur in the use of any medicine that might be found serviceable to mankind. It is certain that some of them have prescribed electricity, in various cases, and have prescribed it with success. Others, also, have lately very candidly told us, (what, indeed, we were tolerably well convinced of before) that *temperance* and *exercise* are the two most potent *drugs* in the whole *materia medica*—though some of us seem to think them the most naucious.

THE *apothecary* would certainly have but little reason to complain, though electricity should come into general use, for, till intemperance and luxury become *unfashionable*, his drugs and compounds, to which mankind seem to have an inviolable attachment, will still continue to be in demand—till *that time*, poor Human nature is doomed to groan under complaints, for the removal of which, *electricity* may be as vainly administered as the whole class of *exotics*.

IF any medical gentlemen should be disposed to treat the subject as chimerical, and unworthy of their sanction, because it has not yet been treated of *systematically*, or because they cannot easily conceive, why the

transmission of a simple fluid through the disordered body, should be attended with so many salutary consequences, I shall readily acknowledge myself unable to account for the operation of so singular a remedy—it may be sufficient to claim their attention if the fact be confirmed by the evidence of sense—and I can only appeal to the many cases which may be brought, as *stubborn facts*, to prove the reality of the cures which have been effected merely by electrical treatment, and which cannot be denied without denying the testimony of a cloud of witnesses.

It is certain, that a seasonable application of electricity, has repeatedly been found extremely beneficial in a variety of cases; in some, where drugs have failed, it has proved of the utmost service; in others, it has appeared favourably to co-operate with other medicines, and has frequently superseded their use. Besides the almost immediate removal of acute pains, and many dangerous complaints arising from obstructions, flatulencies, &c. it has been found of singular utility in some chronical disorders of long standing, particularly of the nervous kind, of which, perhaps, there is scarcely a species, but what would yield, in a greater or less degree, to a judicious and persevering use of electricity.

As the electric fluid is supposed to be the only one in nature that is capable of instantly pervading the finest tubes, and of actuating both the solids and fluids of the animal frame, with vibrations more or less forcible, as the nature of the case requires, its superior efficacy, (when frequently repeated and varied) in the removal of those disorders which proceed from an obstructed circulation, seems to be a consequence naturally arising from the peculiar action of this fluid.

ONE thing, however, appears to be a little remarkable, in favour of electricity, as a medicine, that
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though it has often fallen into the hands of very unskilful and injudicious persons, who have apply'd it at random, in all cases, without being capable of distinguishing either the nature of the disorder, or the degree in which it ought to be administered, yet it has seldom or never been known to be attended with any bad effects; the patient has generally been relieved, and very frequently cured, but the ill consequences have been even more rare than those of inoculation.

If then, nine persons out of ten, whose cases were proper for electrical treatment, have been either cured or considerably benefited by it, which, I think, I may venture confidently to assert has been the case, whenever it has been duly apply'd, and continued; and if not one person in a hundred has received the least injury from it, which may very reasonably be presumed, —I conceive this to be an argument pretty strongly on the side of electricity, which can scarcely be urged in favour of any one remedy beside.

WERE it any argument against electricity to say, It has frequently been administered without effect, —the same might be urged against every medicine that has yet been made use of; or, if it were known to be really prejudicial in some cases, it would make no more against the use of it in others, than against the use of *bark*, or *rhubarb*; and it would be as absurd to expect certain relief from electricity, in any case, as to expect infallible benefit from the use of any drug whatever.

MANY people, unacquainted with electricity, are too apt to treat it with neglect; others, who may have experienced it to be really beneficial in various cases, have, perhaps, rated it too highly, and seem to expect from it more than we can reasonably suppose it capable of effecting. As I apprehend, the chief, if not the sole benefit arising from electricity, is effected by
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the *action* of that fluid, either in producing a tremulous, vibratory motion throughout the solids and fluids in general, and thereby accelerating the circulation of the latter; or, (particularly in the case of obstructions) by actually pervading the finer channels of the fluids; by which means, those passages may be opened, and the viscous, stagnant fluid agitated to its natural subtilty. If any thing like this be the case, the physician will, doubtless, be able to point out what are those disorders, that are most likely to be removed by such a treatment; and, at the same time, see that there are some complaints which cannot possibly be benefited by it.

As the best medicines in nature are liable to abuse, so, without doubt, it is possible to render electricity very injurious to the human frame. But I conceive it to be impossible that the least injury can arise from the *quality* of electricity; for, as this fluid is found to be as natural and common to all bodies as the *air*, it must be both *necessary* and *agreeable* to the human body. The injury therefore, that can possibly ensue, must arise from the *quantity* alone—from the too violent vibration given to the muscles—the sudden distension and contraction of the finer tubes and vessels—and the *resistance* made by the bones and sinews (which are less perfect conductors) to the passage of the electric fluid, in turning it out of its direct course—this must occasion what is generally called the *shock*, which may be rendered too violent to be suffered without considerable inconvenience, particularly to persons of weak and tender nerves.

But the present more judicious method of applying electricity has rendered it evident that no case requires any of those violent shocks, which were used to be given, without distinction of disorder or patient, and which must have been attended with very ill consequences,

quences, if the electric fluid, even when compressed in large quantities, was of a nature in any measure prejudicial.

WERE I really capable of advancing a *system* of medical electricity, and of deducing a series of positions and rules for its application, drawn from mature knowledge and observation of the subject,—yet I am sensible that an attempt of this kind, might be thought arrogantly assuming a character which cannot consistently belong to my situation in life; but, as I can by no means lay claim to any such qualifications, I am as sensible that what I have already written, must stand somewhat in need of an apology; and the best I can offer, is the motive which induced me to write it—a desire of accelerating the progress of electricity, by exciting others, who have more leisure and abilities, to make public the observations that may occur to them; which I conceive to be the most likely means of promoting a liberal enquiry into a science, which appears to be worthy of the most assiduous attention.

It is certain, that whatever concerns the health of mankind, is a subject of too serious a nature to be committed to any other prescriptions than such as are drawn from reason and experience; I am therefore extremely diffident in advancing any other directions for the use of electricity, than those which have been repeatedly used with success. I have, indeed, conceived a variety of modes, wherein it might be apply'd, in different cases; but want of leisure, and opportunity of reducing them to practice, renders them too precarious to be mentioned. The methods I shall venture to recommend are, either such as I have used myself, or have known to have been used by others, and attended with very agreeable effects.

S E C T. II.

*Various Ways wherein ELECTRICITY has been apply'd,
and found serviceable in the Removal of different
Complaints.*

THE most usual method of applying electricity, is that of transmitting a quantity of the fluid through such parts of the body, as are affected, and thereby producing a kind of vibratory motion in the muscles, fibres, &c. This, as before observed, may be rendered more or less forcible, as the nature of the case may be supposed to require. It is attended with a very sudden, but transient sensation, rather disagreeable than painful, usually termed the *electric shock*.*

THIS method often appears to be not only adviseable, but expedient, when the disorder is of such a nature that it cannot be sufficiently affected by the electric fluid, without its being condensed in the coated phial: as in many cases of obstructions, fixed pains, and most of those acute complaints which demand immediate relief. But even here, very *violent shocks* seem by no means necessary. By violent shocks I mean such as may be rendered by means of the full charge of a jar containing two or three gallons: A jar of one gallon, about half or three parts charged, is generally sufficient to answer every purpose of electrification; and, in most cases, less than this will be found sufficient.

* I could wish that those who treat of medical electricity, would endeavour to adopt some other more suitable term, for the passage of the electric fluid, than that of *shocking*. It is apt to convey a terrifying idea to a sick person. There is certainly nothing very *shocking* in the case; and the word can never be used with propriety, but when very large jars are made use of, and the explosions rendered exceeding forcible.

sufficiently efficacious, when the patient has opportunity of having the operation frequently repeated.

BUT there are many disorders which are found to yield to the more mild and gentle method, generally called *drawing of sparks*; which, to have the desired effect, should, in most cases, be continued for ten minutes, or a quarter of an hour; and repeated two or three times a day.

OTHER complaints, particularly those of the nervous kind, are frequently relieved by simply electrifying—I mean, a person's sitting in a chair, supported by a board with glass legs, in contact with the prime conductor of the machine, for about half an hour, or longer if convenient, once or twice a day: By this means, while the operation is performing, the person becomes replete with the electric fluid, which circulates in every part, and flies off from the surface of his body. The particles of this fluid being strongly repulsive of each other, and, at the same time attractive of every particle of heterogeneous matter, particularly the animal fluids, it must therefore, in the above circumstances, be vigorously impelled and circulated through every tube.

It has been said, that this method of treatment generally increases the number of pulsations considerably; by which means the circulation of the blood, &c. is supposed to be accelerated; but I cannot say, from the few observations I have made on it, that this is always the case; I have sometimes perceived no sensible difference; at other times there seemed to be an increase of about six or eight pulsations in a minute: The patient, however, generally finds himself more warm, animated, and chearful, after the operation.—It might, perhaps, be worth while to make a few accurate observations on this subject, in order to deter-

mine the different effects (if any) of a *repletion* of the electric fluid in the animal body, and a *privation* of its natural quantity;—which might be effected by placing a person on a board *negatively* electrified.

It is pretty clear that, either the *nature* or *action* of the electric fluid, is highly exhilarating to the human frame. Let a person inclinable to be chilly, languid, inactive, oppressed, or subject to a nervous *lowness of spirits*,—if it be merely for the sake of a *diversion of thought*, let him think of amusing himself with a few electrical experiments—let him rub his machine, and set it in proper order—then, placing himself on the *electrified board*, he will be able (by the help of another person to turn the wheel) to perform most of the experiments of electrical attraction and repulsion, the same as though he did them standing on the floor, by the prime conductor; in fact, he will be a part of the conductor himself, and partake with it of an equal density of the fluid, though totally insensible of its action. He will attract any light substances that approach him, from a non-electrified body. If he holds in his hand some downy feathers, he will find their fibres immediately grow turgid, and become uncommonly expansive. He may charge a phial, by holding the external coating in his hand, and applying the wire to any unelectrified body. He may set fire to spirits, and other inflammable substances;—in short, the variety of experiments that may be performed in this manner, is as engaging as the diversity of agreeable ideas they must excite.

Would a person, in the above circumstances, suffer himself to be persuaded (and such persons have generally need of persuasion) into the use of this placid kind of exercise, for an hour or two every day, varying the mode so as to prevent a tiresome repetition; I should

should venture to assert, that in a few weeks he would find in himself a considerable alteration for the better.

I WILL not say that a person is likely to receive more benefit from this sort of electricity the first, the second, or the third time of his engaging in it, than he might expect from only once or twice using the cold bath, or taking an airing on horseback; but I think he must be pretty far advanced in *hypochondriacism*, to whom the united force of these three specifics, does not afford effectual relief in less than three months.

A most excellent kind of exercise for such persons, if they are not too lazy, or too obstinate to use it, is *rubbing an electric glass tube*. This tube is generally about three feet in length: It may be rubbed with a piece of flannel, or oiled silk. Holding the tube by the end, in one hand, and the flannel in the other, let it be rubbed briskly up and down, till the tube appears to be excited. The knuckles being then apply'd, with a quick motion, from the lower end of the tube to the top, the electric matter will rush from it with a crackling noise, and, in the dark, will have the appearance of streams of fire. Let a person exercise himself smartly in this manner for a quarter of an hour, and I'm persuaded, if he is not of a habit uncommonly phlegmatic, he will find himself in an agreeable perspiration. He will not only receive the benefit of the *exercise*, which actuates every muscle, but also that of a *double current* of the electric fluid; first, from the floor, through his body and one of his arms, to the tube, where it will be accumulated; then, by successively applying the knuckle of his other hand along the tube, he will again receive the fluid through him, and convey it back to the floor. In bad weather, when a person is obliged to confine himself to his chamber, this flux of ethereal matter may, perhaps, not improperly be considered as a desirable *succedaneum* for exercise in fresh air.

IN electrifying for any particular complaint, when the coated phial is made use, I cannot conceive it to be of much importance what course the fluid is directed to take—whether it be *to* or *from* the part affected; as, supposing the case to be rheumatic, and the seat of the disorder to be chiefly in one arm and shoulder, it seems not very material, whether the current of electric matter be directed so as to enter the shoulder, and come out at the hand, or the contrary. But, if this should be thought of any consequence, it may be proper to remind the reader that, after the phial is charged in the common manner, at the prime conductor, when the discharge is made, the fluid passes from the *inside*, through whatever conductors form the circuit, to the *outside* coating: Consequently, in the above case, if the person holds in his hand a chain in contact with the outside of the phial, and another chain be fixed on the shoulder; as soon as this chain is brought to touch the prime conductor, the discharge will be made, and the fluid pass in at the shoulder and out at the hand.

IN drawing the electric spark, the person who approaches the conductor receives from it the fluid, into whatever part of his body is apply'd to it: But if he sits upon the electrified stool, the fluid is taken from him when the sparks are drawn. This may very conveniently be done another way, without the stool, by means of an *insulated discharging rod*.* The chain of this rod being fastened to the *negative* conductor, (while the prime conductor leads the fluid to the earth by means of a chain) a person may then draw sparks from himself, by holding the discharging rod by the middle of the glass tube, and applying the end of it to any part of his body.

WHEN

* This discharging rod consists of a thick brass wire, run through a tube of glass—having a chain at one end, and a brass ball at the other.

WHEN the stool is made use of, care should be taken that no part of the clothing touch the floor, or other non-electric, so as to convey off the fluid.

As the electric sparks cannot easily be drawn through a quantity of thick clothing, particularly woollen, it will be most convenient to take them from the bare skin; If they are found to be too pungent, a piece of tinfoil, or thin sheet lead, may be placed over the part, which will render them more mild, and the operation may be continued longer.

In most cases it may be proper to begin with drawing of sparks from the part affected, and then proceeding to moderate discharges of the phial. These discharges may be varied in strength, and given in different directions; changing the place of the conducting chains, sometimes farther off, then nearer to the seat of the complaint, by which means, part of the fluid must necessarily pass through it; in general, however, the nearer the chains are kept to the affected part, the better.

It is observable that, though those parts of the body which are disordered, by obstructions, &c. may not be more tender or sensible than the rest, yet the patient commonly feels the passage of the fluid through such places, much more sensibly than in any other part, if the chain is properly placed; excepting only the extremities, where the chains touch the skin.

WHEN a person has once or twice made use of the electrical machine, he will very readily be able to judge what number of discharges, and what degree of force are requisite to be used. Few cases, perhaps, require more than ten or a dozen moderate shocks, at one time of electrifying: But, in general, the more frequently these are repeated, so as not to render the operation disgustful, the sooner may permanent relief be expected.

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It is by no means to be supposed, that the effect of electricity will always manifest itself immediately after the first operation. Though there are some complaints which will sometimes be immediately removed, there are more that require a frequent repetition, before much sensible benefit arises. Others have been found not to yield in any degree to the power of electricity, for some weeks, till, by persevering in the use of it, and by varying the method, they have at length been entirely reduced.

If, therefore, we find electricity to be attended with little or no effect after the first or second time, it seems to be no indication of an unsuccessful repetition; and I am inclined to think, that where it has been apply'd without success, (when the case has been a proper subject for it) its failure has generally been owing to the irresolution, and dislike of the patient, or to an improper method of application, rather than to the inefficacy of the remedy.

It would, perhaps, be to very little purpose, to attempt laying down particular directions for the application of electricity, even in the most common cases: The situation of patients, who are proper subjects for electrical treatment, is generally so precarious as to admit of but few rules but what are discretionary, and variable according to different circumstances. Whoever has formed a general idea of the mode of operation, his judgement may soon lead him to distinguish the most judicious method of applying it in particular cases. I shall, however, mention a few, which may be of service to those who are strangers to the subject, and then proceed to some of the cases in which electricity has been of singular service.

In most disorders arising from obstructions, it is generally necessary to direct the passage of the fluid, by means of the coated phial, immediately through
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the parts affected; and sometimes, if the complaint be more general, all over the body, by placing the chains in various directions: They may be held in the hands, or put under the feet; they may be laid upon any of the limbs, the head, or any part of the body; the passage of the fluid will always be from one chain to the other, the shortest way it can take, and the vibrations will be made in every part that lies in the course of its direction.

THE momentary sensation of pain at each discharge of the phial, which is chiefly felt at the two places where the ends of the chains are fixed, may be rendered much less acute, by means of a thin piece of lead, of a circular or oval form, about an inch and half broad, fastened to the end of each chain—a piece of paper, or thin leather, may be pasted over the lead—this being pressed pretty close to the flesh, by holding it down with a silk handkerchief, or piece of flannel, takes off so much of the pungency of the discharge, that it is sometimes far from being disagreeable.

IF the pain or seat of the disorder, be in the breast, stomach, or arms, the most ready way of conveying the fluid to it, is to let the patient hold in his hand the end of the chain that communicates with the outside of the phial, and, in the other hand, a chain fixed to an electrometer; this being placed about a quarter of an inch, more or less, from the prime conductor, will receive the sparks from it, when the phial is charged; and the fluid will be conveyed through the affected part.

WHEN it is required to give an universal vibration throughout the body, the person may stand upon a pewter or tin plate, and let the end of a chain drop down on it, from the outside of the phial. When the phial is charged, he may touch the conductor with a small metal rod, held in either hand, or else hold in
his

his hand the chain of the electrometer. If he applies the rod to the conductor, let him hold it in such a direction, that the back of the hand may be *upward*, and touch with the rod the *lower*, or under part of the conductor, by which means he can never strike it, so as to throw it down.

AGUES, Epileptic, or Hysteric-Fits, and other complaints in which the whole body is affected generally require these universal vibrations; and a larger quantity of the fluid is requisite to be compressed in the phial, than when the shock is designed to be only partial. A quantity moderately large, is generally attended with a less acute sensation than when it is smaller.

DEAFNESS has been frequently cured by transmitting a small quantity of the electric fluid through the head; a chain being placed to each ear; one of the chains fixed to the outside of the phial, the other to the electrometer—the phial being but lowly charged.

SOME Obstructions are easily removed by the person's standing on the ends of two chains, hanging down on the floor, one of them from the outward coating of the phial, the other from the electrometer—the charges being moderate, and the operation repeated twice or three times in twenty-four hours.

SWELLINGS in the face, neck, or other places, are oftentimes very soon reduced by a few moderate discharges of the phial through the part; but these will frequently be found to yield to the drawing of strong sparks from the place, without using the phial.

A SORE-THROAT, when taken on the approach of the first symptoms of the disorder, is generally effectually cured by a person's standing on the electrified board, and drawing strong sparks from different parts of the throat, for about ten minutes.

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COAGULATED-BLOOD is very soon dispersed by the same method.

THE extravasation of blood in the eyes, commonly call'd *blood-shot*, has been remov'd very speedily by drawing of small sparks from them,—the eye-lids being closed. There is a small instrument, consisting of a glass tube, and adjusting wires, made on purpose for this use: Likewise, another for conveying the electric matter to the teeth, by which the most violent *tooth-achs* have sometimes been instantly cured.

S E C T. III.

A Collection of various Cases, and Cures effected by ELECTRICAL TREATMENT.

IT has been chiefly from observing the operations and phænomena of nature, that men have attained to such a knowledge of her laws, as to be able to pronounce many of them invariable; and from hence they are constantly led to expect similar effects from a sameness of cause.

NATURE, however, is found to be subject to so great a variety of irregularities and disorders, that philosophers, of the most penetrating genius, have never yet been able to trace them to their original spring. The utmost they have been able to do, has been to link together a chain of consequences,—from these *effects* (by pursuing an analytic method of reasoning) to form some probable conjectures concerning the *cause*;—and to evade some of those calamities which have been termed the evils of *nature*, by calling in the assistance of *art*.—And, indeed, to do thus much, seems to be an arduous task for feeble humanity.

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So many are the disorders of the *animal* system, that physicians have found it necessary to arrange them into distinct classes, and to distinguish them by certain appellations and diagnostics. To each of them they have also appropriated the use of certain drugs and compounds, which experience has led them to conclude to be more or less certain *remedies* for those disorders; and, though they seem not yet to be entirely agreed in opinion, which are to be preferred, in some particular circumstances, yet most of them are ready to allow, that practical *experience* is, in general, a more safe guide than theoretical *speculation*.

HENCE they have been industrious to record such particular CASES as they have supposed to be worthy of observation, together with the method of treatment, effects of the medicine, &c.——Cases in PHYSIC, like *Precedents* in the LAW, serve to determine the practice with somewhat more certainty.

WHEN the effects of *electricity* in the cure of some diseases, were first discovered, it was natural that the discoverers should particularly remark the cases, and publish to the world this extraordinary remedy. Whether they did this from motives purely benevolent, or with more lucrative intentions, is hard to say; but, whatever were their views, the remarks have certainly been of some benefit to mankind. By repeating, or improving the methods they made use of, many people have got rid of disorders which appeared to be beyond the effects of medicine.

AND, as we are to suppose that electricity has frequently been made use of with little or no success, perhaps, by this time it would have been of more extensive service, if those who were much engaged in it had, like the late worthy and unprejudiced Dr. FRANKLIN, candidly recited the particular cases wherein they might have found it to fail: Physicians would then, by comparing

paring the nature of the remedy with that of the disorder, have been better able to determine how and when to administer it, and in what complaints it would be most likely to succeed.

For a few years past, since I have made any particular enquiries into the subject, I have from time to time collected, from different persons and writers, as many cases as I could; and have now by me some hundreds of them. I intended, by comparing the various accounts, to have digested some of them into separate classes, in order to distinguish, in some measure, the different species of disorders, which appear more or less likely to be benefited by electrical treatment: To class those together that appeared, upon the whole, to be least liable to exceptions, and in which electricity had been attended with the greatest and most constant success,—Others, in which it had proved more dubious, and less efficacious,—Others again, wherein it had failed, or been attended with but little benefit: But finding myself unequal to the task, I must leave it to those who are better able to perform it, and shall only arrange some of the cases in alphabetical order, and insert them generally verbatim as I find them drawn up.

St. ANTHONY'S FIRE.

CASE I. ‘ Having observed (says Mr. LOVETT) ‘ the great efficacy of the electrical æther, in soon relieving most kinds of inflammations, I was inclined ‘ to think the same salutary effects would appear when ‘ apply’d to the *St. Anthony’s Fire*; but, when a case ‘ of that sort offered, the inflammation was so great, ‘ that, at first sight, I almost despaired of success.

‘ ABOUT the middle of the day I made the first trial, ‘ and before night the swelling was much abated, and ‘ in a few days quite cured.

‘ THE operation was simply drawing of sparks, with a finger, or an iron style, while the person was electrified on the resin.’

[LOVETT’s *Electricity rendered useful.*]

CASE 2. ‘ April 2, 1763, my wife walked too long, as appeared by the consequence, in the evening, in the garden. Next morning an Erysipelas appeared in her face. Her chin was swelled, inflamed, and full of small pustules. By night the swelling had reached her right cheek, and was proceeding to her neck and forehead. Her right eye seemed to be closing up, and her whole face was very sore and painful; she also found a sickness at her stomach. She asked, if I did not think drawing sparks from her face would be of service to her. I drew sparks from it for about ten minutes. The inflammation instantly stopped, the sickness went off from her stomach, and the soreness was much abated. She could bear now to press and rub it. Next morning all her face and head was a little swelled; but drawing sparks about five minutes at a time, night and morning for five days, perfectly cured her. She has never had the least appearance of an Erysipelas since.’

[SYMES’s *Treatise on Fire.*]

AGUES.

CASE I. ‘ ANNE HEATHCOTE, daughter of Mr. HEATHCOTE, Brazier, near *Moorfields*, was seized, in May last, with what is commonly called an *Ague in the Head*, having a violent pain in her head, face and teeth. After trying abundance of remedies, to no purpose, she was, in *August*, electrified through the

‘ Before the more convenient method of sitting in a chair, placed on a glass-legg’d board, was used, the patient generally stood on a cake of resin.——The best thing for drawing the sparks, is a discharging-rod, with a brass knob.

‘ the head. ‘ Immediately the pain fixed in her teeth.
 ‘ She was electrified four times more, and has felt
 ‘ nothing of it since.’ [WESLEY’S *Desideratum*.]

CASE 2. ‘ In *January*, 1761, I was apply’d to, for
 ‘ two children (Sons of Mr. CHANCELLOR, Taylor, of
 ‘ *Bristol*, the eldest nine years old, the other five) to
 ‘ electrify them on account of a *Tertian Ague*, which
 ‘ had stubbornly resisted all applications. I ordered
 ‘ the children to be brought to me, just as the ague
 ‘ was coming upon them; Experience having taught
 ‘ me that this is the only time to give the shock with
 ‘ efficacy. They were electrified only twice, and were
 ‘ perfectly cured, by passing thro’ them four slight
 ‘ shocks, two through the stomach, and two through
 ‘ the sides.

‘ In *March* following one of the children fell into
 ‘ the water, and his ague returned. He was brought
 ‘ to me again, but then the electrical shock had not
 ‘ the least effect.’ [SYMES.]

CASE 3. ‘ *March* 27, 1764, walking a little way
 ‘ from my house, and looking on a poor man digging
 ‘ stones, he suddenly dropt his tool, and cry’d out, I
 ‘ can’t work, I must go home. His soliloquy natu-
 ‘ rally led me to enquire, why? Sir, reply’d he, I
 ‘ have had a *third day’s ague* for these six weeks, and
 ‘ now I feel it coming upon me. I took him imme-
 ‘ diately to my machine, and passed four shocks
 ‘ through him cross-ways. Two from the right hand
 ‘ to the left foot, and two from the left hand to the
 ‘ right foot. I saw no more of him till *April* follow-
 ‘ ing; when he told me he never had the ague but
 ‘ once after, and that only for three minutes: He
 ‘ was then well and hearty. His name is WILLIAM
 ‘ CARTER, aged sixty.’ [IDEM.]

BLIND-

BLINDNESS, Decay, or Loss of SIGHT.

CASE I. Extract of a Letter from Mr. FLOYER, Surgeon, at *Dorchester*, to Dr. BENT, at *Exeter*. May 23, 1751.

‘ I HAVE lately had two or three opportunities of
‘ trying the effects of electricity on paralytic persons,
‘ with success: What most tends to prove its good
‘ effects on the human body, is the following case :

‘ A Boy about seven years of age, was taken blind
‘ suddenly in both his eyes, without any previous
‘ fever, pain, or disorder. Three or four days after
‘ he had lost his sight, he was brought to me. Upon
‘ inspecting his eyes, I found the pupil of each so
‘ entirely dilated, that I could not discover of what
‘ colour the iris was, not the least verge of it to be
‘ seen, but the cornea, transparent, appeared one con-
‘ tinued black spot. I told his parents I believed he
‘ would never be able to see again, for there was sel-
‘ dom or never a cure for such disorders of the eyes,
‘ taking the case to be a perfect Gutta serena in both
‘ eyes. I determined, however, to try the effect of
‘ the electrical shock, as I had met with success in
‘ some cases before. Accordingly I fastened a wire
‘ from the outer coating of the phial to his leg, and
‘ another round his head, which being brought to
‘ the conductor produced a strong explosion. I re-
‘ peated the shock three times more. He was put to
‘ bed, and continued there till the next morning in
‘ profuse sweat. He agreeably alarmed his father in
‘ the morning, by saying he could see the window.
‘ When he was brought to me, I perceived a small
‘ circular rim, of a light grey colour, round the out-
‘ side of the iris, and observed that he knew when I
‘ put my hand between his eyes and the light, which
‘ he did not before, tho’ in the sunshine. This gave
‘ me encouragement to repeat what was done the day
‘ before

‘ before. The next day almost half the iris could be
‘ seen, with some small degree of contraction and di-
‘ latation. The third day he could discover and dis-
‘ tinguish objects. The fourth he could distinguish
‘ colours, with brisk contractions of the iris. The
‘ fifth day, after repeating the operation, I observed
‘ the iris to contract and dilate as well as ever; and,
‘ upon a strict examination, found his sight to be per-
‘ fectly restored, and the eyes, in every respect, as
‘ well as if they had never been disordered.’

IN a subsequent letter, dated the *December* following, Mr. FLOYER informs Dr. BENT of the Boy's continuing well. That he had his case attested by those who saw him electrified; and that many, who had heard of this extraordinary cure, came to see, and examine him. He also mentions a circumstance that he had forgot, in his former letter—the application of a blister plaister to the nape of the boy's neck, the day before he was electrified. This he had done the first thing, but never thought of it afterwards, till it was almost dry'd up. He doubts whether this had any share in effecting the cure, but thought proper not to omit the mentioning of every circumstance.

HE likewise informs Dr. BENT of some other cures which he had performed by means of the electric shock, particularly two girls, whom he had cured of obstructions, one of whom had taken medicines for twelve months without effect.

CASE 2. Mr. WESLEY, in his *Desideratum*, asserts the following accounts, transmitted to him from a gentleman of *Newcastle-upon-Tyne*.

‘ LAST week a poor man in *Sandgate*, that had been
‘ blind twenty-four years, was led to the machine. I
‘ set him upon the electrical board, and drew sparks
‘ for about twenty minutes from the pupil of his eyes.
‘ After

‘ After he had rested himself a little, and was able to
‘ look up, he told us he could see *Sidgate*, which he
‘ had not seen for many years before. He could also
‘ distinguish objects in the room, and was able to walk
‘ home without a guide. He came a second time,
‘ and was so much better, that I imagine he did not
‘ think it necessary to come any more.’

CASE 3. ‘ He adds, About the time I wrote last,
‘ a young woman was cured of a fourteen years blind-
‘ ness. She was able, before she went home, to distin-
‘ guish one letter from another.’

CASE 4. ‘ From the same person, a few days af-
‘ terwards, I received the following lines.

‘ THE cure of the blind man of *Newcastle*, has spread
‘ through all the country; in consequence of which,
‘ I am, much against my will, become an oculist.
‘ I have several in hand, among the rest a girl, about
‘ seventeen, has been with me three weeks. Her case
‘ is owing to a film, or skin, grown over her eyes.
‘ It came by the Small-Pox, about twelve years since.
‘ Her friends have had all advice, and used all the
‘ means in their power to no purpose; except that she
‘ has lost her left eye irrecoverably by one of the per-
‘ sons they apply’d to.

‘ WHEN she came to me the iris of the right eye was
‘ very nearly covered with a thick skin, so that she
‘ could do little more than distinguish day from night.
‘ The method I have taken is drawing sparks from her
‘ eye, and sometimes giving shocks, from her head,
‘ or neck, down her arm, to carry off the frequent
‘ complaints of pain and dizziness in her head, which
‘ never fails of succeeding in about ten minutes. We
‘ have electrified her about half an hour, twice every
‘ day. The skin wastes gradually, and daily grows
‘ thinner; so that now the colour of her eye appears
‘ through

‘ through it. The other day, as I had her in hand, she saw the buttons of my shirt sleeve; but her eye is yet very weak.’

CASE 5. ‘ In *January* 1762, a poor woman, aged about thirty, came to my door begging. She was almost blind. On enquiry I found her blindness was caused by a blow with a potatoe, about two years and a half before: It was flung with great force, and struck her in the right eye, with which she had never seen, owing to an injury she had received in her infancy. But the left eye, till that accident, was always strong. An inflammation immediately ensued; and, when she came to me, the right eye was much swelled, and protuberated out of the socket. The anguish was very great, and so affected the left eye, that she had no more sight left than just sufficient to go about to beg.

‘ I TOOK her to my machine, and drew sparks from both her eyes. She seemed better, before she quitted the room; but by next morning was considerably so. After drawing sparks from her eyes, about ten minutes at a time, for four mornings, she so far recovered her sight, that she could see to sew a whole day together. In about five weeks I dismissed her as perfectly cured.’ [SYMES.]

CASE 6. ‘ IN the spring of the year 1763, a lady was persuaded to try the effect of electricity for her sight. It had been gradually decaying for some time. A film could be perceived gathering over the iris, and making its way to cover the pupil. One eye, in particular, was so darkened that she could not see with it either to read or thread a needle.

‘ I DREW sparks from her eyes about the space of three or four minutes every morning, for a fortnight. She found her eyes surprisngly mended;

L

‘ and

‘ and those who stood by could, as it were, see the
 ‘ curtain draw back from the pupil and iris. She at-
 ‘ tended afterwards, at times, for six weeks longer,
 ‘ and when she left me, was able to thread the finest
 ‘ needle, and to read the smallest print.’ [IDEM.]

BRONCHOCELE.

CASE 1. ‘ SUSANNA REA, of *Worcester*, was troubled
 ‘ with a *Bronchocele* (the most obstinate of all swellings)
 ‘ for ten or eleven years. It began on the right side
 ‘ of her wind-pipe, and gradually increased over it,
 ‘ till her neck was more than eighteen inches about.
 ‘ This swelling was electrified; and sparks drawn from
 ‘ it once a day for three months. The swelling is now
 ‘ considerably abated; the smallest part of the neck is
 ‘ not quite thirteen inches, the largest about fifteen
 ‘ and an half. What swelling remains, is at one par-
 ‘ ticular part only, and has now the appearance of a
 ‘ *wen*, but is much more soft, and appears to waste
 ‘ much faster than at first.’ [LOVETT.]

CASE 2. ‘ Another person, troubled with the same
 ‘ disorder, but not of so long continuance, has lately
 ‘ began with the same operations; and the swelling a-
 ‘ bates much faster than the former.’ [IDEM.]

BRUISES.

CASE 1. ‘ WILLIAM JONES, a plasterer, in *King-
 ‘ street, Seven-Dials*, fell from a scaffold. He was
 ‘ grievously bruised, and lay in violent pain, utterly
 ‘ helpless, for two days, when he was brought by two
 ‘ men, to be electrified. This well-timed application
 ‘ of electricity was so effectual, that the man walked
 ‘ home alone, and the next week went to his work.
 [WESLEY.]

CASE 2. ‘ MARY OSGATHORP had her foot bruised
 ‘ by a stone falling on it, which occasioned a running
 ‘ fore.

‘fore. It continued, (tho’ frequently healed for a time) upwards of eight years; but was entirely cured a month ago, by electrifying, and has never broke out since.’ [IDEM.]

BURNS AND SCALDS.

WE have several instances of the good effects of electricity when apply’d immediately after the accident.—The general method is to draw sparks from the place, which generally prevents blisters, and appeases the pain.

COLDNESS IN THE FEET

is likewise effectually cured by a few moderate shocks, daily repeated for some time. The person may stand on a plate of tin, and a chain be fastened to any part of the leg.

CONTRACTIONS.

‘ELECTRICITY has certainly removed so many complaints of this kind, that it deserves to be try’d wherever they occur.’

CASE 1. ‘One who had lost the use of his limbs, from cold, for several years, was, at length, quite restored by the use of electricity.’

CASE 2. ‘Another, whose knee-joint had been above five years contracted from a rheumatism, was able to straighten it after twice electrifying.’

[LOVETT.]

CASE 3. ‘Dr. HART, in a letter to Dr. WATSON, dated *Salop, March 20th 1756*, mentions a cure performed by electricity, upon a woman whose hand and wrist had been, for some time, rendered useless by a violent contraction of the muscles. She was not sensible of the first shock that was given her; but, as they were repeated, the sensation increased, till she was perfectly well. She was also cured a second time, after a relapse occasioned by a cold.’

[PHIL. TRANS.—PRIESTLEY.]

CASE 4. 'But perhaps the most remarkable case that
' has yet occurred of the use of electricity in curing a
' disorder of this kind, and indeed of any that is inci-
' dent to the human body, was of that dreadful dis-
' order, an universal *tetanus*. It is related by Dr.
' WATSON, in the Philosophical Transactions; and
' the account was read at the Royal Society, the 10th
' of *Feb.* 1763. The patient was a girl about seven
' years of age, who was first seized with a disorder
' occasioned by the Worms, and at length by an uni-
' versal rigidity of her muscles; so that her whole bo-
' dy felt more like that of a dead animal, than a liv-
' ing one. She had continued in this dismal condi-
' tion above a month, and about the middle of *Nov.*
' 1762, after all the usual medicines had failed, Dr.
' WATSON began to electrify her; and continued to
' do it, by intervals, till the end of *January* follow-
' ing; when every muscle of her body was perfectly
' flexible, and subservient to her will, so that she
' could not only stand upright, but could walk, and
' even run like other children of her age.' [IBID.]

CASE 5. 'M—D—, had been afflicted with the
' most violent *Cramp* in her legs I ever heard of;
' which disorder seized her before she was twenty years
' of age, and continued (at intervals) till the operation
' was performed, when she was upwards of seventy.
' This was most violent always when in bed, at which
' time she was forced to tumble out on the floor, and
' this, sometimes, twice or thrice the same night:
' The violent convulsed muscular parts forming them-
' selves into distorted ridges, attended with exquisite
' pain, bursting the small blood-vessels, which after-
' wards appeared of a livid hue, for a considerable
' time. This was entirely cured in a few days. The
' operation was shocks only, and performed once a
' day, thus: Having taken off her shoes, she put one
' foot

‘ foot on the end of the chain which came from the
 ‘ outer coating of the charged phial; then putting
 ‘ one end of a thick wire to the other foot, by bring-
 ‘ ing the other end to the conductor, the electric mat-
 ‘ ter was conveyed through both legs, at the same
 ‘ time.’ [LOVETT.]

CASE 6. ‘ Another person, who had rigid knots
 ‘ in the thigh, like those appearing in violent Cramps,
 ‘ though much more soft, and less painful; they were
 ‘ entirely dispersed, in a minute or two, by simply
 ‘ drawing sparks from the part affected.’ [IDEM.]

MR. WESLEY says he never knew electricity to fail,
 when apply’d to that painful contraction called the
 Cramp. [DESIDER.]

DEAFNESS.

‘ WHEN this arises from harden’d wax, or following
 ‘ a fever, it is often cured by only drawing off sparks.’

CASE 1. ‘ At *Stockholm*, a gentleman of distinc-
 ‘ tion, who had been almost *deaf*, a considerable time,
 ‘ with a ringing in his ears, was perfectly cured in
 ‘ three or four minutes.’

CASE 2. ‘ A Man fifty-seven years old, who had
 ‘ been deaf for thirty-two years, was so far relieved in
 ‘ a few days, as to hear tolerably well.’

CASE 3. ‘ SAMUEL JONES, Gardener, at *Lambeth-
 ‘ Marsh*, leap’d into the *Thames*, to save a man from
 ‘ drowning. Hereby he became so deaf in both ears,
 ‘ that he could not hear any sound at all, were it ever
 ‘ so loud. After being once electrified, he could hear
 ‘ the noise of a coach, at some distance. After the
 ‘ third time, he could hear the sound of the electrical
 ‘ machine. He came no more, so it is supposed he
 ‘ is well.’ [DESIDER.]

CASE

CASE 4. MR. WILSON, in his Treatise on Electricity, gives us an account of a remarkable cure which he performed, in the year 1748, on Mrs. M. SMARGINS. She had been deaf (from a cold at first) for seventeen years, and could hear nothing that was said to her, unless spoken very loud in her ear. Mr. WILSON transmitted a small charge through her head, just above the ears. She was immediately sensible of a degree of warmth in her head, from one ear to the other. The discharges were repeated four times, each increasing a little in strength. The warmth increased at each shock, particularly in that ear with which she heard the least, and continued all day, with a kind of twitchings in the ear. The next morning the operation was repeated. The twitchings became more violent, and the warmth greater round the ears. These effects continued all the day, and she heard considerably better. On continuing this method for a few days, she was perfectly restored to her hearing, which continued without a relapse.

AT the time when she was first electrified, she had a cold, and her eyes were much inflamed. The inflammation decreased after the first operation, and was entirely removed immediately after the second.

WE have many instances wherein electricity has been successfully apply'd in cases of deafness; but the success seems rather dependant on some concurrent circumstances; either the time or mode of application, habitude of the patient, or state of the disorder; for we have also many other instances in which it has either been of very little service, or totally failed. Mr. WILSON says, he afterwards repeated this method with six other persons, but it was not attended with the same success.

MR. FERGUSON likewise informs us that he cured a man who had lost his hearing, by only twice drawing sparks

sparks from his ears ; and was afterwards as successful with two or three others, whom he electrified in the same manner.

DROPSY.

‘ MARY BAKER, Chairwoman, aged 27, living at Mrs. HUNT’s, in *Neal’s-Yard*, near *Seven Dials*, having been long ill of a Dropsy, was admitted last year into *St. George’s-Hospital*. But, on *Nov. 28*, she was discharged out of it, as incurable ; as she was also from the *Westminster-Infirmiry*. In spring last she was electrified, and soon after parted with several gallons of water. After being twice more electrified she was well, and able again to earn her living.’

[WESLEY’S *Desider.*]

THIS, I think, is the only case of a Dropsy, that I have met with, in which electricity has been apply’d.—The cure, as here recited by Mr. W. appears very extraordinary. In what *manner* the woman was electrified, he does not mention. His recital of many of the cases is too laconic. To say, A person was *electrified* and *cured*, is somewhat like saying, He *recovered* by *taking Physic*.

EPILEPSY, and FITS of various Kinds.

CASE I. ‘ My Servant, C. P. had many years been afflicted with *Hysteric Fits*. In 1761 I sent her an Out-Patient to the Infirmiry, which she attended several months, but to appearance, without the least good effect.’ Her fits increased, and her constitution seemed much weakened. At last, I proposed Electricity to her. She received several shocks, but not the least good or ill effect could be perceived from them. Thinking with myself that I might have given the shocks at an improper season, I changed the time, and gave them to her when the fit was upon her. The effect was now astonishing.

‘ The

‘ The fit ceased. The convulsions were quieted, and
‘ she was enabled in five minutes to go about her usual
‘ work; whereas, when the fit was left to itself, it
‘ weakened her so much, that it was sometimes near
‘ two days before she recovered that little strength,
‘ that the fits had left her. I pursued this method.
‘ Her fits gradually lessened, and at length ceased.

‘ BUT I must here inform the reader, that in the
‘ spring 1762, I advised her to use the Cold Bath,
‘ which did her much good. This she has continued
‘ every summer since, and at the writing this, *Dec.*
‘ 1764, she continues in perfect health, and has had,
‘ from her own account, but six fits, and those chiefly
‘ from surprise, since she left off the use of electri-
‘ city, which was from the time of her first using the
‘ Cold-Bath.

‘ I PASSED the shocks thro’ the heart, and from the
‘ right shoulder to the left side, and then from the
‘ left shoulder to the right side. When she was much
‘ convulsed, I passed the shock from the left hand to
‘ the right foot, and then from the right hand to the
‘ left foot.’ [SYMES.]

CASE 2. ‘ SARAH BETTESWORTH, aged 22, then
‘ living in *Cow-Lane*, was some years since seized with
‘ so violent fits, that five or six men were scarce able
‘ to hold her. In autumn 1756, while she was in one
‘ of them, she was electrified. The phial was apply’d
‘ to one shoulder, as she lay on the ground, and the
‘ wire to the other. On the first shock her struggling
‘ ceased, and she lay still. At the second her senses
‘ returned. After two or three more, she arose in
‘ good health. Some months after, she relapsed, and
‘ was electrified again, and again entirely cured. Last
‘ Easter she fell into a fit again, through a fright;
‘ but by a few shocks was cured, and restored to
‘ health. [WESLEY.]

CASE

CASE 3. ' WILLIAM MATTHEWS, Schoolmaster, near *Moorfields*, aged 32, had *Epileptic Fits* (supposed to be hereditary) from his birth, till he was six years old. Thence he was free till thirteen. They then returned on occasion of a fright, and continued so to do twice or thrice in a year, till he was seventeen. From that time they came almost every month, till the year 1753; since then they usually returned, about once in ten or eleven weeks. In the middle of *March* last he began to be electrified, both through the head, and from head to foot. *April 4*, he had a slight fit; but from that time to this, *Nov. 1*, has had none at all.

MR. W. asks, ' Can all England afford such a cure as this, wrought by a course of medicines?'

[DESIDER.]

CASE 4. ' A young Lady had been afflicted with fits near seven years, which seized her without any warning, and threw her on her face quite insensible. These frequently returned twice in a day. This was attended with almost a continual coldness in her feet. Her stomach also was much affected. She was electrified by standing upon a wire from the coating of a phial, and to complete the circuit, another wire was laid upon her head. By this means, both the fits and coldness were gradually removed, and a complete cure effected.' [WESLEY, LOVETT.]

CASE 5. ' ELIZ. BUND, near the *Old Hills*, a few miles from *Worcester*, had for fifty years been afflicted with severe fits, which, like an Epilepsy, gave her no warning, but threw down in an instant to the ground, and continued her in a state of insensibility for a considerable time. She was attacked by these fits sometimes twice or three times in a day. After being electrified, upon her return home, she found such a surprising amendment, as encouraged her to

M

' come

‘ come to *Worcester*, as often as she had opportunity,
 ‘ in order to repeat the operation; the consequence of
 ‘ which, was the gradual decrease of an inveterate
 ‘ Head-ach, which attended her disorder; and, at
 ‘ last, the total cessation of the fits; for, instead of
 ‘ being seized with them twice or thrice a day, after
 ‘ she had began these electrical operations, she had
 ‘ no more than about four of them, and those greatly
 ‘ weakened; and, as she has none of them since *Christmas*,
 ‘ 1753, there is sufficient reason to hope they
 ‘ will not return. The operation was shocks chiefly.
 ‘ Signed *Sept.* 12, 1754.’ [ID.]

FROM the variety of cures, in Hysteric and similar cases, which Mr. LOVETT effected by Electricity, he supposes it to be peculiarly serviceable in disorders of this kind, but observes that, ‘ In these complaints, it
 ‘ is not to be done by *halves*; not for a few minutes
 ‘ only, (which is sufficient in some others) particularly
 ‘ if it has taken deep root; but the person ought to
 ‘ stand or sit on the electrified stool for an hour in the
 ‘ morning, and another in the evening each day; or,
 ‘ if two hours a day cannot be comply’d with, let
 ‘ it be two half hours; This may be first practised
 ‘ with sometimes simply drawing off sparks; afterwards with some slight shocks, and then, if the disorder requires it, to be increased with more. Such
 ‘ proceeding I seldom found to fail of the desired
 ‘ effects.’

FEET violently disordered.

CASE I. ‘ JOHN WEBB, of *Worcester*, seventy years
 ‘ of age, was much disordered in his feet, for ten or
 ‘ twelve years. The pain resembled that of the Gout,
 ‘ but such a *coldness* attended it as was scarcely support-
 ‘ able. If he warmed them by the fire, they raged
 ‘ still more, as also when he began to be warm in
 ‘ bed. The nails of his toes frequently dropt off:
 ‘ The

‘ The toes in general appeared livid ; and frequently
 ‘ large black, or bluish spots were formed on the ends
 ‘ of them, or on the top and sides of his feet ; and
 ‘ his heels were generally puffed up like blown bladders.

‘ ALL these complaints gradually decreased, till
 ‘ they were totally removed, by his being electrified
 ‘ once a day, for sometime, and afterwards twice a
 ‘ week. At first only sparks were drawn. Afterwards,
 ‘ the chain was brought from the outward coating of the phial,
 ‘ to the part affected of one foot ; then one end of a wire
 ‘ was laid to the part affected of the other foot, and the other
 ‘ end of the wire brought to the conductor.’ [LOVETT.]

CASE 2. ‘ ESTHER HOPKINS, of *Tedney*, near *Worcester*,
 ‘ was troubled with a very painful swelling, in the ball of her
 ‘ great toe, for some years. The pain was greatest when she was
 ‘ in bed. Having, in vain, made use of other means, she came to
 ‘ *Worcester*, to try the effect of electricity. After the first or second
 ‘ operation, the pain was much abated ; and she told me, with
 ‘ pleasure, she had had a more comfortable night’s rest than
 ‘ for a considerable time before. After continuing the use of
 ‘ electricity for a small time longer, the swelling gradually
 ‘ assuaged, and the pain left her. The operation was setting
 ‘ her upon a cake of rosin, and drawing sparks from the part
 ‘ affected.’ [ID.]

CASE 3. ‘ MR. JOSHUA WADE, of *Perthore*, was for
 ‘ seven or eight years troubled with a painful disorder in one
 ‘ of his toes ; and though it was tender as a boil, yet nothing
 ‘ was to be seen. The pain was so great that he was
 ‘ determin’d to have the toe cut off.

‘ THIS troublesome malady was effectually cured at
 ‘ one operation ; which was performed in the same as the
 ‘ above.’ [ID.]

FELONS.

IN an account from *Upsal*, in *Sweden*, by Dr. ZETZELL, we are informed that these are brought to a speedy digestion, and cured, by drawing electrical sparks from them: But no particular case is mentioned.

FISTULA LACHRYMALIS.

‘ ANNE THOMASON, in *Little Fish-street*, *Worcester*,
 ‘ was troubled with a Fistula near the inner corner of
 ‘ her eye, which broke out and healed no less than
 ‘ seven times. The last time it healed, it continued
 ‘ well for some time; after which it began with a small
 ‘ swelling, and continued growing larger, till it was
 ‘ as big as a filbert; when she was advised to try elec-
 ‘ tricity. After the swelling was electrified, it soon
 ‘ decreased, till it was entirely dispersed; and has con-
 ‘ tinued well for more than two years, without the
 ‘ least symptom of any return of the disorder.—The
 ‘ operation was simply drawing sparks from the part
 ‘ affected.’ [LOVETT.]

GOUT.

I FIND but few instances of the effects of electricity in this inveterate disorder. Though, according to Mr. LOVETT, electricity has frequently been made use of, with great success in it; and he is of opinion, that complaints of this kind, even tho’ hereditary, would, in time, be found to give away, if not quite cured, by electrical treatment. He mentions his having made some trials on persons slightly attacked by the Gout, who received benefit so suddenly, that they could scarcely think it to be the effect of electricity. He asserts the following

CASE I. ‘ A Person in *Worcester* had, within the
 ‘ space of two or three years past, several attacks of
 ‘ the Gout, since the first of which, he had always a
 ‘ stiffness and pain in the joint of one of his great toes,
 ‘ and

‘ and for a considerable time, in both, particularly if
 ‘ he walked much. He was quite cured in a short
 ‘ time, by having sparks drawn from the part affected.’

CASE 2. ‘ The following remarkable case (says the
 ‘ Rev. Mr. SYMES) was not performed by myself, but
 ‘ by a friend, who particularly desired that I would
 ‘ insert it in my list. It is here introduced with fan-
 ‘ guine hopes that others would make trial of electri-
 ‘ city in the same case; being thoroughly persuaded
 ‘ that the remedy will be found, if not effectual, yet
 ‘ most certainly innocent. The short of the relation
 ‘ is this. A young gentleman, fond of electricity,
 ‘ went to his Tinman’s for something he had bespoke
 ‘ of him, who at that crisis was thought to be dying
 ‘ of the Gout in his stomach. He was desired to go
 ‘ up stairs: As soon as the poor man saw him, Sir,
 ‘ says he, for God’s sake electrify me. The machine
 ‘ was brought, and several shocks were given through
 ‘ the stomach, where the pain was felt. The patient
 ‘ every time begged that the shocks might be stronger.
 ‘ At last a great quantity of wind came up, and he
 ‘ immediately cry’d out, “ I am better.” That night
 ‘ he rested tolerably well. The Gout almost instantly
 ‘ shifted from his stomach to his feet. But next day
 ‘ making too free with himself, and drinking some
 ‘ ale, the Gout returned to his stomach. The shocks
 ‘ were repeated, and the patient’s account was, “ I
 ‘ feel the Gout retire to my feet.” He was cured.—
 ‘ Some years after I saw him, conversed with him, and
 ‘ heard the above particulars from him.’

GRAVEL.

‘ THOMAS WILLIS, Chair-maker, aged 44, was for
 ‘ many years afflicted with the Gravel in his kidneys.
 ‘ He was electrified twice. After the second time he
 ‘ parted with a large quantity of Gravel. He was
 ‘ elec-

‘ electrified twice more, and has not found the least
‘ complaint since.’ [DESIDER.]

I FIND no other case of the gravel, wherein electricity has been made use of, than this one—but, if the nature of the disorder be considered with that of the remedy, those obstructions arising from gravel seem to be no improper subjects for electrical treatment; at least, I think no ill consequences can ensue from it, and it may be worth while to make trial of a few discharges of the phial, tolerably forcible, from the reins, or between the shoulders, to the feet.

HEAD-ACH.

ELECTRICITY has been of very considerable service in violent Head-achs, as appears from the number of cases we find recorded.

CASE 1. ‘ Mr. HIGGINS, in *Lich-street, Worcester*, troubled with a periodical Head-ach for near six weeks, from the top of his forehead, or right temple, down to his ear, which commonly began at five or six o’clock in the evening, and held till he went to bed, was cured in a few minutes.—The operation was drawing sparks from the part affected.’

[LOVETT.]

CASE 2. ‘ M. DANCOCKS, near *Sidbury-Gate, Worcester*, was afflicted with an almost constant and violent pain in the hinder part of her head, for near three quarters of a year; but worst of all when she first lay down in her bed, being then so intolerable, she could not forbear shrieking. Having made use of all means in her power to no effect, was very soon relieved of the violence of the pain, by being electrified once a day; and, after continuing it some time longer, declared herself perfectly cured.’ [ID.]

CASE

CASE 3. 'A. T. of *Whitechapel*, had a violent
' Head-ach, which continued for seven or eight weeks.
' After she was electrified the pain increased for three
' hours. It then gradually decreased, till she was quite
' well. This proves that electricity may remove even
' a disorder which, at first it seems to increase.'

[DESIDER.]

CASE 4. 'A. BROWN, aged 22, was from a child
' frequently afflicted with a violent Head-ach. In *Oct.*
' 1757, she was electrified five days successively; hav-
' ing one wire apply'd to the fore part, another to the
' hinder part of her head, and receiving seven or eight
' shocks each time.' Hereby she was entirely cured,
' nor has found any pain in her head since, unless oc-
' casionally for want of sleep.'

[IBID.]

CASE 5. 'SARAH WEBB, wife of Mr. WEBB, Tal-
' low-chandler, aged 46, was from twenty years old
' subject to a violent pain on the top of her head.
' This frequently obliged her to keep her bed; nor
' could any remedy for it be found. She was electri-
' fied by gentle shocks from temple to temple, and
' from the forehead to the back part of her head.
' This was done three days successively, and she was
' entirely cured.'

[IBID.]

CASE 6. 'R. OUTEN, Rope-maker, aged 23, liv-
' ing in *Bunhill-Row*, was troubled with a violent
' Head-ach over the eyes, before he was ten years old;
' arising from a blow on the head. He was scarce
' free from it a month together, for above twelve
' years. It used to throb and shoot through the head,
' so that often he was almost distracted. He was
' once electrified, receiving three shocks, by one wire
' apply'd to the forehead, and another to the back
' of the head. He was worse than ever for some hours,
' till he went to bed, but awaked in the morning per-
' fectly well; and has continued so ever since.'

[IBID.]

IN most of the foregoing cases, the disorder appears to have taken its rise either from external injury, or some other extraordinary cause;—In a common head-ach, proceeding from indigestion, fatigue, &c. electricity seems to be of very little service.

HYSTERIC COMPLAINTS, DEPRESSION, &c.

THE salutary effects of electricity, in various cases of this nature, have been very remarkable. We have several instances of persons who have been entirely relieved of such complaints, though of many years standing, by repeating the use of electrical applications, in various modes, for the space of a few months.

MORTIFICATION.

MR. LOVETT gives us one instance of a Mortification, which he had surprisingly benefitted by electrical treatment. The patient was a gentleman of *Worcester*. The complaint began in his toe, and the mortification proceeded, notwithstanding every probable remedy was apply'd. At length he was electrified, and several charges of the phial sent through the part. The mortification stopped; but, upon omitting the electricity, it began again, and increased so far that the case seemed desperate. He was again electrified in the same manner, which, by the next morning, produced such a change for the better as astonished the Surgeon, who acknowledged it had done more good in two days, than had been effected in six weeks before.

PARALYTIC DISORDERS.

THIS appears to be an extensive field for electrical operations, in which the success has been extremely various. The benefit of electricity, in some of these complaints, has been remarkable,—in others, apparently similar, it has been found of very little service.

THE

THE Rev. Mr. W. JONES, in his *Essay on NATURAL PHILOSOPHY*, relates the following remarkable cure.

CASE I. ' A Girl of about twelve years of age, the daughter of a Shepherd in the parish of *Wadenbo*, in *Northamptonshire*, having frequently exposed herself in the field, to bad weather, was afflicted in the spring 1761, with flying pains in her limbs, soon followed by an *bemiplegia*, which seized her suddenly as she was at work, and deprived her of the use of her limbs on the right side; so that she was unable to stir from her chair. She complained also of a fixed pain toward the bottom of the spine, which became so violent, that, when in bed, she could rest in no posture but with her face downward.

' To remove this symptom, a blister was recommended to be laid near the part. It had the desired effect, and removed this pain in a day or two; but her limbs, on the right side, were still as useless as before, and so invincibly cold, that her mother was employed many times a day in rubbing them with hot flannels.

' THE blister was continued under the form of a perpetual blister: But I found, after some trial, that no farther benefit was to be expected from it; and having but little hope from the use of any external medicines, I resolved to electrify her.—The shock was given after the common method; only I endeavoured to administer it in such a manner, that the fire, upon its discharge, should follow the course of the nerves (from the top of the spine downwards) throughout the whole side that was affected. After two or three strokes, of which she complained but little, though they were very severe, I enquired, Whether she perceived any warmth or tingling in her limbs? To which she answered in the affirmative. When she had received about half a dozen

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' strokes,

‘ strokes, I dismissed her, ordering her parents to wrap
‘ her up warm in bed immediately, and bring her to
‘ me again in a day or two.

‘ AT her next appearance, she was much altered for
‘ the better : Instead of that cold and numbness she
‘ had before complained of, her limbs had a glowing
‘ warmth in them from the time she had left me; and
‘ this was followed by a profuse sweating, which came
‘ on after she was put to bed, and continued for about
‘ two days after the first operation. There was like-
‘ wise *a copious discharge from the blister*, which, for
‘ some days before, had produced no effect, and was
‘ in a manner dried up.

‘ AFTER the *second* operation she continued to mend.
‘ After the *fourth*, she went by herself, upon crutches,
‘ to a neighbouring house, at some little distance. At
‘ this time, the shocks began to hurt her so much as
‘ to make her shed tears; a plain proof, that her
‘ limbs had now, in a great measure, recovered their
‘ sensibility. After the *sixth* operation, she was able
‘ to walk up a steep hill to church, without any as-
‘ sistance, even from a walking-stick : And during
‘ this whole course, no medicines of any kind were ad-
‘ ministered. Some weakness still remained, which
‘ electricity would not remove; I therefore recom-
‘ mended the use of the cold bath, by the help of
‘ which she soon recovered her strength, and is now
‘ able to work for a livelihood nearly as well as be-
‘ fore, except that her right leg is somewhat shorter
‘ than the other, which, as she walks, necessarily occa-
‘ sions her to sink a little on that side.

AFTER reciting the above case, the same gentleman
observes of medical electricity, from the opportunities
he has had of trying its power, that, though it ought
not to be hastily cried up as a cure for all diseases,
(which has been the misfortune of many an useful re-
medy)

medy) some there certainly are, to which it may be apply'd with success; and says, he should be glad (and every benevolent mind will wish with him) to see its usefulness properly ascertained, and discreetly limited, by some candid and judicious gentlemen of the faculty. He farther observes, that, from what has appeared to him, he believes it might be of much service in *rheumatic pains*, and *paralytic affections*, where they are recent, and the patient not too far advanced in years. Some of the principal disorders arising from *obstructions* (he adds) might find great help from it, if taken in time: And he supposes it might be worth while to try it in the case of a *gutta serena*, or any other disorder that may be referred to this class, which is a very numerous one.

BUT he thinks, its greatest efficacy will be found in removing (and that in a very small space of time) all *spasms* or *cramps*, particularly such as proceed from any sudden *cold* upon the external parts; and supposes it highly probable, that in the most extreme cases of this kind, immediate relief might be expected from it, even in that dreadful spasm which affects the muscles of the back or breast, and is so common both in the *East* and *West-Indies*. This disorder is described by BONTIUS, in his *Hist. Nat. & Med. Ind. Orient.* p. 18. "*Tam repentinus & subitus est aliquando ejus impetus*" &c. The same species of disorder, I apprehend, which is usually called a *tetanus*. Mr. JONES, here, undoubtedly appears to be right in his conjecture, for a *tetanus* has been cured by electrical treatment."

WHAT led him to believe that electricity might be of the utmost service in this frightful distemper, was the case of one of his maid-servants, who, by taking cold in the night, arose in the morning with that spasm commonly called a *crick* in the neck; so violent, that her

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" See p. 76.

her head was drawn aside toward one shoulder, and could not be moved any way without causing an acute pain. He ordered her to be placed on a stand, supported with glass feet, and drew sparks from the part where the greatest pain was felt, when she attempted to move her head. By this means, in a minute or two, her head came nearer to its right position, and by continuing the operation, was very soon restored. Some soreness remained in the part; which was removed by keeping her neck warm. All the sparks that were drawn raised so many little red pustules or blisters; which is not usual if the part be in a healthy state. But, to return from this digression from paralytic disorders.

CASE 2. ‘ JOSEPH BURGESS, aged 22, applied to me
 ‘ in Feb. 1761. Two years before, returning from sea,
 ‘ he was impressed into the King’s service, in the *Bristol*
 ‘ channel, and with several others was sent to navigate
 ‘ a prize round to *Plymouth*. He had not been long
 ‘ on board, before he was struck with a *hemiplegia* on
 ‘ the right side. When the Vessel arrived at *Plymouth*,
 ‘ he was sent to the Hospital. He continued there, his
 ‘ mother informed me, three months, without receiv-
 ‘ ing the least benefit. She then removed him to *Bris-*
 ‘ *tol*, and by the help of friends, got him admitted
 ‘ into the Hospital at *Bath*, where he remained seven
 ‘ months, but to no purpose. She then removed him
 ‘ back to *Bristol*, and got him admitted into the Infir-
 ‘ mary, where he continued three months, and was
 ‘ then dismissed as incurable.

‘ SOME time after this, his mother applied to me;
 ‘ at this crisis, his right leg was almost useless, he had
 ‘ no strength to lift it up, he could only drag it after
 ‘ the left. His right arm was wither’d, and seemed
 ‘ only to hang to his shoulder, and his fingers were
 ‘ fast clenched, and quite inflexible; nor was he able
 ‘ to

‘ to speak one articulate word. I gave him 30 or 40
‘ smart shocks for several mornings, and had soon suf-
‘ ficient reason to think that I should be of service to
‘ him; for the parts, which were at first insensible,
‘ began to recover their feeling, his fingers unclench-
‘ ed a little, and looked of a living colour. In two
‘ months his leg recovered so much strength, that he
‘ could walk with freedom; and I could perceive the
‘ flesh of his arm grow and increase apace; by this
‘ time he could lift it to his head, and move his fin-
‘ gers. I ordered him to use his arm as much as he
‘ could. In a little time he recover’d so much strength,
‘ that he was able to work at a pump for half an hour.
‘ He attended three months, and then of his own ac-
‘ cord left me. His flesh became sensible, and the
‘ shocks gave him pain, which was the reason of his
‘ coming no more.’ [SYMES.]

MR. SYMES adds, that the man, soon after, went to work in a brick-yard, and that in the year 1766, he saw him at work, wheeling a barrow, which, by the help of a strap round his wrist, he seemed to manage as well as his fellow-labourers. Some of his fingers were still rigid and contracted; and he was able to articulate but few words. Had he continued the use of electricity, Mr. SYMES apprehends he might have been perfectly cured.

CASE 3. MR. LOVETT gives us an account of a cure which he performed on a person who had a sudden stroke of the palsy in his arm, which remained useless for some time, but was restored by means of friction. The stroke was repeated a second, and a third time; when he was effectually cured by few electric shocks.

THE same person had lately a much worse stroke of the same kind. All the right side was so affected, that he could not walk without the assistance of two persons
to-

to support him. After he had been electrified a few times, he was able to walk with the help of one person, and in three weeks was perfectly restored.—The operation was shocks from the right hand, to the right foot.

CASE 4. ' THOMAS DOBSON, Leather-pipe-maker, aged 27, was seized with a palsy in the tongue. It continued to grow worse for some days, and then quite deprived him of his speech. He was electrified for five days, by drawing sparks from the tongue, and shocking him all over. By this means not only his palsy was cured, but convulsions also, which he had had for four years.' [DESIDER.]

MR. WESLEY, in his *Desideratum*, written about twelve years ago, acknowledges that he had not himself, at that time, known any instance of the perfect cure of a *hemiplegia*; ' Many *paralytics* (he says) have been helped, but I think scarce any palsy of a year's standing, has been thoroughly cured.'

THIS melancholy disorder, perhaps above any other, requires a most judicious treatment.—The following case seems to be an instance of an injudicious application of electricity. Dr. HART, of *Shrewsbury*, in a letter to Dr. WATSON, says, ' A young girl, about sixteen, whose right arm was paralytic, on being electrified the second time, became universally paralytic, and remained so about a fortnight, when the increased palsy was removed by medicines which her case indicated; but the first diseased arm remained as before: I should have mentioned too, that this arm was greatly wasted, in comparison of the other. However, notwithstanding the former bad accident, I had a mind to try the effect of electricity on her again, which we renewed; and, after about three or four days use, she became, the second time universally paralytic, and even lost her voice, and with
' dif-

‘ difficulty could swallow. This confirmed me in my
 ‘ opinion, that the electrical shocks had occasioned
 ‘ these symptoms.—We therefore omitted it, and the
 ‘ girl, though she grew better of her additional palsy,
 ‘ for so I call it, remained as bad as before of her
 ‘ first.’ [PHIL. TRANS. Vol. 48. 1754.]

THIS appears, pretty clearly, to be one instance that electrical treatment improperly apply'd, may be attended with ill effects; and I think it is the only one worthy of notice, that I have met with.—From the consequences which ensued from Dr. HART's method of electrifying, we may very reasonably conclude that the shocks were too violent. Though the Doctor was, no doubt, a man of discernment, it seems very probable that he did not sufficiently attend to the particular circumstances of this poor girl's case. Perhaps the number of patients, and variety of business in an *Hospital* (where, I think, electricity is not likely to receive its last improvement) might oblige him to proceed with less precaution than such an experiment required. The complaint was in the arm only; and the arm alone should first have been shocked. At that time, indeed, it was not known, at least it does not appear to have been sufficiently attended to, that a large quantity of the electric fluid, instantly transmitted through any part of the body, would affect the whole, and be productive of one rude concussion (properly termed a *shock*) throughout the whole frame,—and that a quantity more moderate, would affect little more than the part which lay immediately in its circuit or passage.—But this was *the trial of a new remedy*, on a patient of the lower class.

DR. HART seems to have been generally pretty liberal in the use of his medicine, and never stinted his patients in quantity. In a preceding part of his letter to Mr. WATSON, he mentions the case of another woman,

man, whose arm had been paralytic for some years, so as to be ever absolutely motionless, and insensible of heat, cold, or pain; and says that the *greatest blows* were given to it for many days successively—it is much that this woman was not likewise *universally paralytic*—but, notwithstanding this rough treatment, the arm, it seems, grew better, and she recovered some little use of it.

DR. FRANKLIN seems likewise, in some measure, to have fallen into this mistake, of supposing that a large quantity of the electric matter, and very forcible explosions were necessary to be made use of in this disorder. In a letter to Dr. PRINGLE, read at the Royal Society in *Jan.* 1758, he says, that a few years before, when the news-papers made mention of several considerable cures performed in *Italy* and *Germany* by electricity, a great number of *paralytics* were brought to him, from different parts of *Pensilvania*, and the neighbouring provinces, to be electrified. His method was, after placing the patient on an insulated stool, to draw a number of strong sparks from all parts of the affected limb or side. He then fully charged two six gallon glass jars, each containing about three square feet of coated surface, and sent the united *shock* of them through the affected limb or limbs, repeating the stroke commonly three times each day.

By this treatment most of the patients appeared to be relieved, for a few days; a greater sensible warmth was observed in the affected limbs, which were found more capable of voluntary motion, and seemed to acquire more strength. These appearances, he says, gave great spirits to the patients, and made them hope for a perfect cure; But he did not remember to have seen any amendment after the fifth day.—The *shocks* became severe—the patients were discouraged—went home, and in a short time relapsed.

IF,

IF, instead of *two six gallon jars*, the Doctor had made use of only one of *two quarts*, and proportioned the shocks as the patients were able to bear them, at the same time using a gentle external friction with flannels, oils, &c. the benefit, perhaps, might have been much more permanent. Indeed he himself afterwards supposed that many small shocks would have been more proper than the few large ones he gave; having read, in an account from *Scotland*, of a case in which two hundred shocks (or rather small discharges) from a phial were given daily, and a perfect cure had been made.

MR. JAMES FERGUSON, in his Treatise on electricity, relates a remarkable cure of a *Hemiplegia* performed by Mr. WM. SWIFT, of *Greenwich*. The patient was the Wife of Mr. ALLMEY, a Baker. The affected side was totally insensible. Dr. GREEN, who attended her, ordered her to be electrified; which was done by drawing of sparks, sometimes for more than an hour together, and then proceeding to the use of the charged phial. The discharges were made pretty strong till she began to feel them, and then more moderate. The operation was begun *Sept. 3, 1769*, and continued till the 18th of *Oct.* following, in which time she was electrified for the space of 31 hours, at 18 different times, and had received 141 shocks. She was hereby quite restored.

UPON the whole we find that electricity has been of very considerable service in this disorder; but the success appears greatly to depend on a proper and well timed application; and I think, not only the *degree* and *duration* of the disorder, but the strength and constitution, the age, sex, and habitude of the patient, should be so far considered as in some measure to determine the mode of operation.

RHEUMATISM.

THE general method of treating *rheumatic* complaints and fixed pains in the limbs, proceeding from colds &c. is first drawing of strong sparks from the affected parts, and then making use of the coated phial. The former method alone, has often been known to remove rheumatic pains of many years standing; and in many cases of this sort, a few electric shocks has effected cures after other remedies had been used to no purpose.

SCIATICA.

CASE 1. ‘ Mr. JOHN ELLISON, an Officer of the Excise, living in *Hunt-street, Spitalfields*, was upon catching cold, seized with a violent *Sciatica*, which held him several months without intermission, and frequently almost took away the use of his limb. In *Aug. 1754*, he was electrified, receiving two shocks. His pain was greater for four or five hours, but afterwards entirely ceased, and returned no more.’

[DESID.]

CASE 2. ‘ MARY BUTLER, aged 86, of *Eagle-street, Red-Lion-Square*, had been afflicted with a *sciatica* for more than twenty years, she was electrified ten or a dozen times, and has been easy ever since.’ [IBID.]

CASE 3. ‘ A Lad who had a severe *sciatica* in the right hip, from a fall from a scaffold, so as not to bear being touched, was so far cured by electricity in a few days, as to be able to walk without a staff.’

[LOVETT.]

CASE 4. ‘ THOMAS FRANKLAND, an Invalid, but discharged on account of what was thought an incurable malady, was seized with a violent and most excruciating pain in the upper part of his thigh. It had tormented him for three months before he came to me, and

‘ and had rendered his life perfectly miserable. He was
 ‘ cured by electrifying him only twice. I passed about
 ‘ six shocks through the pain. This poor fellow’s gra-
 ‘ titude was so great that, at whatever distance he saw
 ‘ me, he would always run and be ready to throw him-
 ‘ self at my feet. [SYMES.]

SORE THROAT.

CASE 1. ‘ ELIZ. TAYLOR, of *Hennick’s-Hill*, near
 ‘ *Worcester*, after taking cold, was seized with a sore
 ‘ throat, which continued growing worse for the space
 ‘ of six days; at which time she could not swallow even
 ‘ a bit of bread soaked in tea. She came to *Worcester*
 ‘ to try the effect of electricity, and received so much
 ‘ benefit from it, that, by the time she got home, she
 ‘ was able to eat some boiled mutton. After being
 ‘ electrified twice more she was perfectly cured.—The
 ‘ operation was small shocks, from one side of the
 ‘ throat to the other.’ [LOVETT.]

CASE 2. ‘ I was once, at *Bristol*, seized with a sore
 ‘ throat, so that I could not swallow any thing. Mr.
 ‘ ADLAM, of that city, who is a fine electrician, came
 ‘ and drew many electric sparks from my throat; and
 ‘ in about half an hour after, he did the same again.
 ‘ He stay’d with me about an hour longer, and before
 ‘ he went away, I could both eat and drink without
 ‘ pain; and had no return of the disorder.—I have re-
 ‘ lieved several persons in such cases, but never in so
 ‘ short a time as Mr. ADLAM cured me.’ [FERGUSON.]

I HAVE frequently had the satisfaction of proving the
 good effects of electricity in this complaint, both on
 myself and others.—I never made use of the coated
 phial in this case, but drew very strong sparks from
 different parts of the throat and neck, by means of an
 insulated discharging rod, in contact, by means of a
 chain, with the *negative conductor*. I always found this

method attended with success, if the operation was performed soon after the first symptoms of the disorder appeared.

SPRAINS, SWELLINGS, &c.

CASE 1. ' JOHN PAGLAR, Mason, being at work
' in *Redcliff-street*, March 1762, had the misfortune,
' by carrying a Stone too heavy, to wrench his knee;
' it swelled immediately, and was very painful.—He
' apply'd to a surgeon, who told him, he imagined it
' would be some time before it would be cured. The
' next morning he came to me, but with great diffi-
' culty and much pain. I passed about five shocks thro'
' the swelling; this enabled him to bend his knee, and
' walk about the room without difficulty. I ordered
' him to favour his knee that day as much as he could,
' and come to me the next morning. He came, but
' perfectly cured with what was already done. The
' swelling was gone, and he could bend his knee and
' walk as well as ever.' [SYMES.]

CASE 2. ' JACOB GRIFFITH, a sea-faring man, ap-
' ply'd to me *May 21*, 1765, to electrify him for pains
' and swellings in his legs and arms. He told me that
' he had been discharged from the *HOPE* Man of war,
' as incapable of service, and that he had likewise been
' dismissed from the *Portsmouth* hospital, as incurable.
' He was cured by shocks, attending only four days.' [ID.]

CASE 3. ' S. W. in the year 1762, had the mis-
' fortune to cut her hand with the edge of a tin box.
' The wound was trifling, but, in a day or two it grew
' painful. An eminent surgeon dressed it. It grew
' worse; and at last became so bad, that it was con-
' cluded, in order to save her life, she must lose her
' hand.—After repeated applications, however, they
' succeeded so far as to heal the wound. In the summer
' 1765, she was directed to me. I do not remember
' ever

‘ ever to have seen a hand so distorted. It was much
 ‘ wasted, as was also her arm. She was always in pain,
 ‘ and her fingers and hands had lost all feeling.

‘ HAVING never had a case similar to this, I could
 ‘ not give her much encouragement. I could only say
 ‘ that no one could positively declare what electricity
 ‘ would not cure, broken bones excepted.

‘ HER feeling was so lost, that at first she did not
 ‘ perceive the shocks in her hand, though I gave her
 ‘ several smart ones. The fourth morning she began
 ‘ to feel; this encouraged me.—In ten days there was
 ‘ a manifest appearance for the better: Her pain was
 ‘ taken off, and her hand and arm were so strength-
 ‘ ened that she could lift a chair. After this her joints
 ‘ began to appear, and her fingers to be flexible; for
 ‘ before, there was no bending in her fingers, nor a
 ‘ knuckle to be seen.—She told me she could feel the
 ‘ finest needle, and use it with ease; the shape of her
 ‘ hand also was much altered for the better.’ [ID.]

CASE 4. ‘ The wife of Mr. EVANS, Corn-chand-
 ‘ ler, of *Bristol*, had a fixed and sharp pain in the
 ‘ small of her back, caused, as she apprehended, by
 ‘ frequent miscarriages. No cost had been spared to
 ‘ obtain a cure: The ablest physicians had been con-
 ‘ sulted, and the Bath had been tried. When she came
 ‘ to me to be electrified, she said she had not lain down
 ‘ in her bed for a twelvemonth, but was obliged to be
 ‘ bolstered up; and if at any time she fell in her sleep
 ‘ on one side, she was awakened with a pain, as if
 ‘ needles were piercing her.

‘ I PASSED four shocks through the place where the
 ‘ pain was fixed. The next morning she came to me
 ‘ full of spirits, telling me she had lain down in her
 ‘ bed, had slept soundly, and that the pain was almost
 ‘ gone. I passed four shocks more through the pain;
 ‘ and

‘ and she felt no more of it then ; but taking too great
‘ liberty with her new-acquired strength, and lifting
‘ something too heavy for her, her pain returned, but
‘ not with violence. — A few shocks removed it.’ [ID.]

CASE 5. ‘ Mrs. H. Wife of Mr. H. in *Pipe-Lane*,
‘ for five years had been so afflicted with acute pains in
‘ her left leg and right arm, that her life was rendered
‘ quite miserable. Her leg was so benumbed, that it
‘ had lost its feeling.—When she was brought to me,
‘ May 6, 1765, she was so weak, that it was with
‘ difficulty she was kept from fainting; but notwith-
‘ standing she was thus reduced, in five days, by the
‘ help of two persons, she was able to walk to my
‘ house. The shocks removed her pains almost imme-
‘ diately, and the second day of her attendance, the
‘ numbness was taken off, and she began to perceive a
‘ feeling in her leg. After attending about twenty
‘ times, she was perfectly cured.’ [ID.]

CASE 6. ‘ In *February* 1765, my wife, after lying-
‘ in, was seized with an almost total loss of the use of
‘ her limbs. Not a joint was free from excruciating
‘ pain. She appeared so bad that blisters were judged
‘ needful. Accordingly two were applied to the small
‘ of her legs. When she was able to sit up in bed,
‘ she begg’d I would electrify her. Her knees swelled,
‘ her ancles spread, and not a joint in her hands but
‘ what was enlarging. The effects of the shock was
‘ surprising; it reduced the swellings, took off her pains,
‘ and caused her to have good nights. But what is
‘ remarkable, such a deadness fell on the places where
‘ the blisters were put, that for a long time she had
‘ not the least feeling in the small of her legs. I have
‘ the greatest reason to believe that electricity, un-
‘ der God, preserved her life; for besides what I have
‘ mentioned, there were strong symptoms of a dropsy.
‘ I passed the shocks through her pains, and sometimes
‘ shocked

‘ shocked her whole frame, giving the shock from
 ‘ hand to foot. These shocks, she said, did her most
 ‘ good. She recovered. But a weakness continued in
 ‘ her legs and ancles. A Cramp teaz’d her for a long
 ‘ time after, but electrifying always relieved her. [Id.]

CASE 7. ‘ WM. ROWE, second-mate of the *Glo-*
 ‘ *cestershire*, from an injury he received in being bled
 ‘ in his arm, had so painful a swelling there, that he
 ‘ had scarcely any sleep for six weeks. Every necessary
 ‘ remedy was apply’d, but he received no benefit.—
 ‘ He came to me *July 6, 1761*; he was then in great
 ‘ misery. The swelling was very large, and so hard
 ‘ that I could not make the least impression on it with
 ‘ my finger. His hand was withering, and the whole
 ‘ arm so weak, that he was obliged to rest it in a sling.
 ‘ —I gave him between thirty and forty shocks the
 ‘ first time. The night following he slept better than
 ‘ he had done from the time of bleeding, and said that
 ‘ the pain was nearly taken off. I perceived the swell-
 ‘ ling to be abated one third. I gave him as many
 ‘ shocks as the day before; and, to my great astonish-
 ‘ ment, when he went from the machine, he took his
 ‘ sling, which was a silk handkerchief, from his neck,
 ‘ and put on his coat with ease. He was perfectly
 ‘ cured in about three weeks. I passed the shocks
 ‘ chiefly through the swelling, and from the shoulder
 ‘ down to the hand.’ [Id.]

CASE 8. ‘ The Wife of Mr. PRICE, Blacksmith,
 ‘ in *Bristol*, had been for some time confined to her
 ‘ room, by what the apothecary judged to be a *White*
 ‘ *Swelling* in the knee, and of a very dangerous na-
 ‘ ture.—She was brought to my house in a chair, I
 ‘ passed several shocks through the swelling, and from
 ‘ the knee down to the foot. Her pain, which was
 ‘ very great, was soon taken away, and in a month’s
 ‘ time she was able, by the help of a crutch, to walk
 ‘ to

‘ to my house. She was perfectly cured in three months.’ [ID.]

CASE 9. ‘ FR. HALFPENNY, Taylor, in *Redcross-street, Southwark*, when about 18 years of age, had a fall from a tree. By this he received so violent a sprain, that he could not walk twenty yards, unless exceeding slow, without a gnawing, aching pain down his thigh. In *Sept.* last he was electrified through the upper part of the thigh. This was repeated at five or six different times. The first shock removed the pain down to the knee. At the third electrifying it went quite away. And since that time he has been perfectly well.’ [DESIDER.]

I MIGHT innumerate a variety of other cures effected by electricity, not less remarkable than any of the above, from several other writers, and many more that are recent in this City; but I have already exceeded the limits I intended for the particular cases; I was led on by the consideration that some person or other, might probably meet with a case similar to his own, and to such I imagin’d the relation might appear in some measure interesting.

WHILE I was writing some of the above cases, an observation or two occurred to me which, tho’ perhaps of no great consequence, may not be amiss to mention, as every particular effect of electricity seems to be worthy of notice.

ONE circumstance attending some of the preceding cures, particularly that of the *paralytic*, related by Mr. JONES,* was a fresh and copious discharge of the *blisters* which had previously been apply’d to the patients. — This, I think, seems to be a pretty general consequence of electrification; at least I have myself known many instances of it; particularly in one gentleman, whom I electrified for a paralytic complaint, and who had

* See page 89.

had a blister apply'd to the back part of his neck. He informed me, that, in the nights after his being electrified the preceding day, he found a much more copious discharge from the blister than at other times; though the operation was no more than his standing, for about a quarter of an hour, on the insulated stool, while sparks were drawn from the side of his face.

FROM hence it appears not improbable, that, in some cases, blisters may be attended with peculiar benefit, during a course of electrical treatment; in others, perhaps, it might be worth while to make use of electricity, merely to obtain a favourable discharge from the blisters.

I HAVE also observed, that a copious *perspiration* is frequently an effect of electricity, particularly when the coated phial is made use of. This, indeed, may partly proceed from the apprehension, generally awakened in the patient, of experiencing a disagreeable sensation, which occasions a more than ordinary exertion of the faculties, as well as from the action of the fluid itself; but I have sometimes been led to think, that this circumstance is so far from being unfavourable, that, in many cases, it contributes to accelerate the cure.

I SHALL observe of the preceding cases in general, that they appear to be a simple narrative of facts, related by men whose principal motive in writing on the subject, seems to have been benevolence; and who, I think, could by no means have been interested in exaggerating their accounts.

WE may, at least, from hence conclude, that an electrical treatment of various disorders, strongly claims the attention of those who have leisure and abilities to investigate its mode of operation. It is from such pens—it is from the calm and liberal enquirer, divested of the prejudice of *hypotheses*,—that we are to expect the
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advancement of genuine science. When the nature and effects of the electric fluid have been duly enquired into; its analogy to some other articles of the *Materia Medica* pointed out, and the most consistent method of application determined, we have great reason to expect it will be attended with very considerable and extensive use.

THE chief *desiderata* seem to be, the distinguishing of such diseases as are most proper for electrical treatment,—and applying it, at a favourable crisis, in the most effectual manner: But the vague and desultory method in which electricity has generally been made use of, has frequently rendered the success of the operation precarious.

I AM sensible it is not from a recital of the *cures* which have been effected by electricity, that this method of treating diseases is likely to become adverted to; but rather from a rational conviction of its utility.—The Physician who has formed his system of drugs, and whose rules of practice are established by reason and experience, will possibly impute those cures to a *favourable concurrence of circumstances*, rather than to the effects of a medicine which, perhaps, he has not thoroughly examined. He will, doubtless, also observe, that some of the preceding cases are liable to *exceptions*; Others, in which electricity appears to have been the principal, if not the sole agent concerned in the cure, may still be said to be *facts without demonstration*;—they appear to be wrapp'd in an air of *mystery*, and the agent is of too subtle a nature to be the subject of analysis.——Time and industry, however, may possibly so far unfold the veil, as to discover to us in a clearer light, the connection between the *cause* and *effect*; and that the action of the electric fluid, may be considered as a simple *remedy of nature*, in many of her disorders.

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I MIGHT have been a tacit advocate for medical electricity, merely from observing its beneficial effects in such cases as I have been an eye-witness to; but I should scarcely have hazarded my sentiments on the subject to public view, if I had not found them corroborated by those of many sensible and ingenious men, whose investigations and experiments are not so liable to deception: I shall therefore take the liberty of concluding this subject with a few extracts from the Rev. Dr. PRIESTLEY's *History of Electricity*; in one section of which he has exhibited the sentiments of different writers on the subject; and has selected and arranged his materials, with the same candour and perspicuity which distinguish the other parts of his work.

S E C T. IV.

Extracts from Dr. PRIESTLEY's History. Period X.
Sect. XIV.

Of MEDICAL ELECTRICITY.

THE subject of medical Electricity falls almost wholly within the period of which I am now treating. For, though some effects of electricity upon animal bodies had been noted by the Abbe NOLLET, and a few diseased persons had said they had received benefit from being electrified; yet very little had been done this way, and physicians had scarcely attended to it, till within this period; whereas electricity is now become a considerable article in the *materia medica*.

THE first account I have met with of the application of electricity to medical purposes is that of Mr. C. KRATZENSTEIN, professor of medicine at *Halle*; who, in the year 1744, cured a woman of a contracted finger

in a quarter of an hour. He also so far relieved a person who had two lame fingers, by once electrifying them, that he could play upon the harpsichord, which he had before been disabled from doing. He also observed, that a man's pulse, which had beat eighty in a second before he was electrified, immediately after beat eighty-eight, and was presently increased to ninety-six.

THERE is another celebrated instance of the cure of a palsy before this period; which is that performed by Mr. JALLABERT, professor of Philosophy and Mathematics at *Geneva*, on a Locksmith of the age of fifty-two, whose right arm had been paralytic fifteen years, occasioned by a blow of a hammer. He was brought to Mr. JALLABERT on the 26th of *Dec.* 1747, and was almost completely cured by the 28th of *Feb.* 1748. In this interval he was frequently electrified, sparks being taken from the arm, and sometimes the electric shock sent through it. Mr. JALLABERT's own account of this cure is very circumstantial.

THE report of this cure performed at *Geneva*, engaged Mr. SAUVAGES of the Academy in *Montpelier*, to attempt the cure of paralytics, in which he had considerable success.—The concourse of patients of all kinds, which the report of these cures brought together, was prodigious. For two or three months together, twenty different patients were electrified every day. It is not surprising to find, that the neighbouring populace considered these cures as an affair of witchcraft, and that the operators were obliged to have recourse to their priests to undeceive them. In the course of these experiments it was found, by very accurate observations made with a pendulum, that electrification increases the circulation of the blood about one sixth.

ONE of the first who attended to electricity in a medical way, was Dr. BOHADTCH, a Bohemian; who, in a treatise upon medical electricity, communicated to the

the Royal Society, gave it as his opinion, after the result of much experience, that of all distempers, the *hemiplegia* seemed to be the most proper object of electricity. He also thought it might be of use in intermitting fevers.

THE Palsy having happened to be the first disorder in which electricity gave relief, there was a considerable number of cases published pretty early, in which the paralytics were said to have found benefit from this new method of treatment. In the year 1757 Mr. PATRIC BRYDONE performed a complete cure of a hemiplegia, and, indeed, an almost universal paralytic affection, in about three days. The patient was a woman, aged 33, and the palsy was of about two years continuance. And J. G. TESKE, very nearly cured a young man, of the age of 20, of a paralytic arm, of which he had not the least use from the age of five years.

THE Abbe NOLLET's experiments upon paralytics had no permanent good effect. He observes however that, during fifteen years that he had electrified all sorts of persons, he had known no one bad effect to have arisen from it to any of them.

DR. EDWARD SPRY relates a complete cure which he had made of a *locked jaw* and *paralysis*, in the case of a girl of 18 years of age. Small shocks were given to the muscles particularly affected.

THAT there is an intimate connection between the state of electricity in the air and the human body, is evident from several facts, particularly a very remarkable one related by the Abbe MAZEAS, in a letter to Dr. HALES, of a man who was subject to epileptic fits. He was much more affected when it thundered than at any other time; and if it ever happened, which it rarely did, that he then escaped; his eyes, his countenance, and the confusion of his expressions, sufficiently demonstrated

frated the weakness of his reason. It was not the *fear* of the thunder that affected him, but he found a fatal connection between that phenomenon and his distemper; and, when the fit seized him, he perceived a vapour rising in his breast, with so much rapidity, that he lost all his senses before he could call for help.

MEDICAL electricity is very much obliged to the labours of Mr. LOVETT, Lay-clerk of the Cathedral church at *Worcester*, who has for many years been indefatigable in the application of electricity to a great variety of diseases. His success has been very considerable, and all the cases he has published seem to be well authenticated. According to this gentleman, electricity is almost a specific in most cases of *violent pains*, of however long continuance; as in obstinate *head-achs*, the *sciatica*, the *cramp*, and disorders resembling the *gout*. He had no trials of the proper *gout*, but only on those who were slightly attacked, and who received immediate relief.

THE *tooth ach*, he says, is generally cured instantly, and he scarce ever remembered any one who complained of its raging a minute after the operation. It has seldom failed to cure *rigidities* or a *wasting of the muscles*, and *hysterical* disorders, particularly if they be attended with *coldness in the feet*. He also says it has been of excellent use in bringing to a suppuration, or in dispersing without suppuration, obstinate swellings of various kinds, even those that were scrophulous. In the rheumatism he says it has failed; but seldom in the case of young persons, if they were taken in time.

THE manner in which electricity operated in these cures, Mr. LOVETT imagined to be, by removing secret obstructions; which are probably the cause of those disorders. In all his practice he never knew an instance of harm being done by it, and thinks that, in all the cases in which it has done any harm, the manner of administering

ministering it has been injudicious; and in general, supposes that the shocks have been made too great.

THE REV. MR. JOHN WESLEY has followed Mr. LOVETT in the same useful course of medical electricity; and recommends the use of it to his numerous followers, and to all people. Happy it is, when an ascendancy over the minds of men is employed to purposes favourable to the increase of knowledge, and to the best interests of mankind. Mr. WESLEY's account of cures performed by electricity agrees very well with that of Mr. LOVETT, whom he often quotes. He likewise directs nearly the same method of administration.

THIS account of the medical use of electricity by Mr. LOVETT and Mr. WESLEY is certainly liable to an objection, which will always lie against the accounts of those persons who, not being of the faculty, cannot be supposed capable of distinguishing with accuracy, either the nature of the disorders, or the consequences of a seeming cure. But, on the other hand, this very circumstance of their ignorance of the nature of disorders, and consequently of the best method of applying electricity to them, supplies the strongest argument in favour of its innocence, at least. If in such unskilful hands it produced so much good, and so little harm; how much more good, and how much less harm would it possibly have produced in more skilful hands.

BUT whatever weight there be in this objection against the last mentioned writers, it certainly cannot be urged against ANTONIUS DE HAEN, one of the most eminent physicians of the present age; who, after six years uninterrupted use of it, reckons it among the most valuable assistances of the medical art; and expressly says, that though it has often been apply'd in vain, it has often afforded relief where no other application would have been effectual. But I shall recite in a summary manner

manner from his *Ratio Medendi*, the result of all his observations on this subject.

WITH respect to partial *palsies*, in particular, he says, it never did the least harm; that one or two persons who had received no benefit from it in six intire months, were yet much relieved by persevering in the use of it. That some persons discontinuing it, after having received some benefit, relapsed again; but afterwards, by recurring to the use of electricity, recovered, though more slowly than before. Some persons, he says, were relieved who had been paralytic one, three, six, nine, and twelve years, and some longer; but that in one or two of these cases, the patients had received less relief, and more slowly than was usual in recent cases. In some cases, he says, a most unexpected benefit had been found by those who had been paralytic in their tongues, eyes, fingers, and other particular limbs. A *paralysis* and trembling of the limbs, from whatever cause it arose, never failed to be relieved by it; and he relates one instance of a perfect cure being performed in a remarkable case of this nature, after receiving ten shocks.

DR. HAEN's custom was to apply the operation for half an hour together at least. He seems to have used gentle shocks; and he joined to electricity, the use of other remedies, which, however, would not have been effectual without it.

ST. VITUS's DANCE, he says, never failed to be cured by electricity. He always observed it to promote a more copious discharge of the menses, and to relieve in cases of obstruction; but, for this reason, he advises that it be not administered to women with child. He found it of use in some cases of *deafness*; but it entirely failed in its application to a *gutta serena*, and to a *strumous neck*. Lastly he relates a remarkable case, communicated to him by Mr. VELSE at the *Hague*, of the cure of a *mucous apoplexy*. To

To those cases wherein harm may be apprehended from electrification, may perhaps be added the venereal disease, in which Mr. VERATTI advises, that electricity be by all means avoided.

I SHALL conclude this account of medical electricity with observing that there are two general effects of electricity on the human body, of which it should seem, that physicians might greatly avail themselves: These are, that it promotes insensible perspiration, and glandular secretion. The former is effected by simple electrification; and the latter by taking sparks from the glands, or the parts contiguous to them; on which it acts like a stimulus. Of the former, instances have been given in the experiments of the Abbe NOLLET, and a few have been given occasionally of the latter.

To these I shall now add, that LINNÆUS observed, that when electric sparks have been drawn from the ear, it has instantly promoted a more copious secretion of ear-wax; and that it has also been observed, that, when the eye, or the parts about the eye, have been electrified, the tears have flowed copiously. But the most remarkable case that I have met with, is, of its promoting the secretion of that matter which forms the hair; whereby hair has been actually restored to a part that had long been bald.

HITHERTO electricity has been generally apply'd to the human body either in the method of drawing sparks, as it is called, or giving shocks. But these operations are both violent; and though the strong concussion may suit some cases, it may be of disservice in others, where a moderate simple electrification might have been of service.

THE great objection to this method is the tediousness and expence of the application. But an electrical machine might be contrived to go by wind or water, and a convenient room might be annexed to it; in which a floor might be raised upon electrics, and a person might

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fit down, read, sleep, or walk about during the electrification. It were to be wished, that some physician of understanding and spirit would provide himself with such a machine and room. No harm could possibly be apprehended from electricity, apply'd in this gentle and insensible manner, and good effects are, at least possible, if not highly probable. It would certainly be more for the honour of the faculty, that the practice should be introduced in this manner, than that it be left to some rich valetudinarian, who may take it into his head, that such an operation may be of service to him.

S E C T. V.

Dr. PRIESTLEY's *Experiments on ANIMALS.*

AS I have constructed an Electrical Battery of considerable greater force than any other that I have yet heard of, and as I have sometimes exposed Animals to the shock of it, and have particularly attended to several circumstances, which have been overlooked, or misrepresented by others; it may not be improper to relate a few of the cases, in which the facts were, in any respect, new, or worth notice.

JUNE the 4th. I killed a Rat with the discharge of two jars, each containing three square feet of coated glass. The animal died immediately, after being universally convulsed, at the instant of the stroke. After some time, it was carefully dissected; but there was no internal injury perceived, particularly no extravasation, either in the abdomen, thorax, or brain.

JUNE the 19th. I killed a pretty large Kitten with the discharge of a battery of thirty three square feet; but no other effect was observed, except that a red spot was found on the pericranium, where the fire entered. I endeavoured to bring it to life, by distending the lungs, blowing with a quill into the trachea, but to no pur-

purpose. The heart beat a small time after the stroke, but respiration ceased immediately.

JUNE the 21st. I killed a small Shrew with the discharge of a battery of thirty six square feet, but no other effect was perceived, except that the hair of the forehead was singed, and in part torn off. There was no extravasation any where, though the animal was so small, and the force with which it was killed so great. This fact, and many others of a similar nature, make me suspect some mistake, in cases where larger animals are said to have had all their blood vessels burst by a much inferior force.

IN all the accounts that I have met with of animals killed by the electric shock, the victims were either small quadrupeds, or fowls; and they are all represented as killed so suddenly, that it could not be seen how they were affected previous to their expiration. In some of my experiments, the great force of my battery has afforded me a pretty fair opportunity of observing in what manner the animal system is affected by the electric shock, the animals which I have exposed to it being pretty large; so that a better judgment may be formed of their sensations, and consequently of the immediate cause of their death, by external signs. I do not pretend to draw any conclusion myself from the following facts: I have only noted them as carefully as I could for the use of physicians and anatomists.

JUNE the 26th. I discharged a battery of thirty eight square feet of coated glass, through the head, and out at the tail of a full grown Cat, three or four years old. At that instant, she was violently convulsed all over. After a short respite, there came on smaller convulsions, in various muscles, particularly on the sides; which terminated in a violent convulsive respiration, attended with a rattling in the throat. This continued five minutes, without any motion that could be called breathing, but was succeeded by an exceed-

ing quick respiration, which continued near half an hour. Towards the end of this time, she was able to move her head, and fore feet, so as to push herself backwards on the floor; but she was not able to move her hind feet in the least, notwithstanding the shock had not passed through them. While she continued in this condition, I gave her a second stroke, which was attended, as before, with the violent convulsion, the short respite, and the convulsive respiration; in which, after continuing about a minute, she died.

BEING willing to try, for once, the effect of a much greater shock than that which killed the cat, upon a large animal, I gave an explosion of sixty two square feet of coated glass to a dog of the size of a common cur. The moment he was struck, which was on the head (but, not having a very good light, I could not tell exactly where) all his limbs were extended, he fell backwards, and lay without any motion, or sign of life, for about a minute. Then followed convulsions, but not very violent, in all his limbs; and after that a convulsive respiration, attended with a small rattling in the throat. In about four minutes from the time he was struck, he was able to move, though he did not offer to walk till about half an hour after; in all which time, he kept discharging a great quantity of saliva; and there was also a great flux of rheum from his eyes, on which he kept putting his feet; though in other respects he lay perfectly listless. He never opened his eyes all the evening in which he was struck, and the next morning he appeared to be quite blind, though seemingly well in every other respect.

HAVING dispatched the dog, by shooting him through the hinder part of his head, I examined one of his eyes (both of which had an uniform bluish cast, like a film over the pupil) and found all the three humours perfectly transparent, and, as far as could be judged, in their right state; but the *cornea* was throughout

out white and opaque, like a bit of gristle, and remarkably thick.

BEFORE this experiment, I had imagined, that animals struck blind by lightning had probably a *gutta serena*, on account of the concussion which is seemingly given to the nervous system by the electric shock; whereas this case was evidently an inflammation, occasioned by the explosion being made so near the eyes, terminating in a species of the *albugo*; but which I suppose would have been incurable. One of the eyes of this dog was affected a little more than the other; owing, probably, to the stroke being made a little nearer to one eye than the other. I intended to give the stroke about an inch above the eyes.

IN order to ascertain the effects of electricity on an animal body, I, after this, began a course of experiments on the conducting power of its constituent parts; and for some time imagined that a piece of spinal marrow of an Ox conducted sensible worse than the muscular flesh; but after a great number of trials with pieces of spinal marrow from various animals, and pieces of muscular flesh, of the same size and form, and in various states of moisture and dryness, I gave up that opinion as fallacious, but I cannot help wishing the experiments were resumed with some more accurate measure of conducting power than hath yet been contrived.

BEING willing to observe, if possible, the immediate effect of the electric shock on the heart and lungs of animals, I gave June the 5th, a shock from six square feet to a Frog, in which the thorax had been previously laid open, so that the pulsation of the heart might be seen. Upon receiving the stroke, the lungs were instantly inflated; and, together with the other contents of the thorax, thrown quite out of the body. The heart, however, continued to beat, though very languidly, and there was no other sign of life for about

ten minutes. After that, a motion was first perceived under its jaws; which was propagated, by degrees, to the muscles of the sides; and at last the creature seemed as if it would have come to life, if it had not been so mangled. The stroke entered the head, and went out at the hind feet.

JUNE the 6th. I discharged a battery of thirty three square feet through the head and whole extended body of another frog. Immediately upon receiving the stroke, there was, as it were, a momentary distension of all the muscles of the body, and it remained shrivelled up in a most surprising manner. For about five minutes there appeared no sign of life, and the pulsation of the heart could not be felt with the finger. But afterwards, there first appeared a motion under the jaws, then all along the sides, attended with convulsive motions of the other parts, and in about an hour, it became to all appearance, as well as ever.

THE same day, I gave the same stroke to two other frogs. They were affected in the same manner, and perfectly recovered in less than three hours. These facts surprised me very much. I attribute the recovery of the frogs partly to the moisture, which always seems to cover their body, and which might transmit a good part of the shock; and partly to that provision in their constitution, whereby they can subsist a long time without breathing. To ascertain this, I would have given the shock to toads, serpents, fishes, &c. and various other exanguious animals, but I had not an opportunity. Besides, *it is paying dear for Philosophical Discoveries, to purchase them at the expence of HUMANITY.*

THUS far Dr. PRIESTLEY—and I could heartily wish that the many useful hints and observations which are to be found in his work, were attended to by every electrician, till some of the important discoveries, to which they seem to lead, are fortunately obtained, and the track pursued till the science be thoroughly explored.

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ESSAY

ON ELECTRICITY, &c.

PART III.

Miscellaneous EXPERIMENTS and OBSERVATIONS.

FEW or none of the refinements of science afford so agreeable relaxation to the serious and liberal mind as Philosophical experiments. The rational entertainment, and pleasing instruction conveyed by such enquiries, are constantly found to extend the faculties of the soul with an exalted idea of the beauty and sublimity of nature, while they are almost irresistibly led on to contemplate and adore its divine Source.

Few other departments of science yield so pleasing, so various, and, at the same time, so astonishing phenomena, as that of electricity. The variety of appearances produced by an electrical machine, in a copious current of the fluid, are, indeed, sometimes so strikingly curious, that the mind seems to be, in a manner, suspended between admiration of the *effects*, and enquiry into the *cause*. This affection seems to be natural and rational. The human mind can neither cease to admire, nor remain satisfied with vague appearances: The superior objects of its desire are knowledge

ledge and certainty; in the pursuit of which its industry is chearfully exerted, and frequently rewarded with success.

HENCE many electricians have patiently repeated and varied their experiments, till they have at length hit upon something or other which has appeared satisfactory and conclusive. Others, if they have not been quite so fortunate at demonstration, have yet opened the way to farther enquiries, as well as greatly contributed to our amusement, by inventing an agreeable variety of experiments, which, at the same time that they are entertaining, are not without their utility, having a general tendency to illustrate the theory of electricity, and to promote farther discoveries in the science.

I SHALL therefore add a few other experiments to those which have been already recited, chiefly for the sake of leading those who have been but little conversant with the subject, to an acquaintance with a variety of electric appearances, which constantly tend to facilitate a farther enquiry.——But few, indeed, of the following can be called *new* experiments, the greater part of them having been frequently repeated, but the apparatus, and the method of conducting many of them are considerably varied.

It has been before observed, that all electrical appearances depend on the balance of the fluid being more or less disturbed, and that none of those appearances could ever be exhibited unless some bodies were made to contain either *less* or *more* than their *natural quantity*. In order to demonstrate this fact the more easily, and for a great variety of other purposes, it is necessary that the cushion or rubber of the machine be as perfectly insulated as possible, and that a conductor be connected with it (which may be called the *negative*) of the same kind and dimensions as the *positive* or prime

prime conductor. These two conductors, by means of four moveable glass stands, may be placed in any direction that is required; either parallel to each other, obliquely, or at right angles.

If one end of a wire or chain be made to touch the *negative* conductor, while the other end touches the table, the electric matter will be accumulated as much as is possible on the *positive* conductor, and a strong spark may be *taken from* it. If the chain be taken away from the negative, and hung to the positive conductor, upon turning the machine, the negative will be found to have as great a *deficiency* of the fluid as, in the former case, the positive had a *redundancy*, and as strong a spark may be *given to* it: In this case, the electric matter is conveyed, by the friction of the glass, from the rubber and negative conductor, through the pointed wires, to the positive conductor, and from thence, through the chain, to the earth; by which means the negative is deprived of its natural quantity, and becomes in a situation ready to *receive a supply* from any body that approaches it. But, when the chain was hung to the negative conductor, the rubber had a constant supply of the matter from the earth, through that conductor and chain; the fluid was, by the motion of the glass, forced upon the positive conductor, whereby this became in a situation ready to *throw off* its redundant quantity.

LET one end of the chain be hung to the positive, and the other end to the negative, in which case the whole will be insulated, and no supply of matter can be received from the ground; yet there will still be a circulation of the natural quantity contained in the conductors and rubber. The glass cylinder, by its motion, conveys the fluid from the rubber to the conductors (which may now be considered as only one, from their being connected by the chain) and from

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these the rubber is again immediately supply'd. This is easily proved by taking the chain entirely away, and placing the ends of the conductors about an inch distant from each other; upon turning the machine, strong sparks will be seen to issue from the positive to the negative conductor. This can be no other than the fluid naturally belonging to the conductors, for, being both insulated, no part of it can be received from the earth.

IN like manner, a pane of coated glass, a phial, or as many phials as we please, may be *charged* without having any connection with the earth or other non-electric. If the outward coating of a phial be made to rest on either of the conductors, and the wire or hook which communicates with the inside, be placed on the other, upon turning the machine the phial will become charged the same, or rather sooner, than it does when the coating is in contact with the earth, though none of the matter, with it is said to be charged, comes from thence; nor are the conductors themselves robbed of the smallest quantity of their fluid. Hence it is evident that the glass, after it is charged, contains no greater *quantity* of the electric matter than it did before, or than what is at all times natural to it, the fluid being only conveyed from one side to the other. If a charged phial be placed on glass, or suspended by silk, it may be made to explode with a discharging rod held by a glass handle; whereby it appears that the contents of the phial have no tendency to escape into the earth.

A PHIAL may also be discharged in the following manner, which makes an appearance extremely curious in the dark—let the phial be fully charged, and placed on a small glass stand under the recipient of an air-pump; as the recipient is exhausted the electric fire will issue from the wire of the phial in a very luminous pencil

pencil of rays, and continue flashing to the coating till all the air be pumped out, when the phial will be found totally discharged. From this it appears that a *vacuum*, or a space nearly void of air, not only admits of a rapid passage of the electric fluid, but causes it to assume the most lucid appearance.—If the phial be *negatively* charged, the current of fire will appear to have a contrary direction to that which it had before.

As the force of an electric charge is not lodged in the metallic coating of the glass, the glass may be divested of its coating and yet remain charged.—Take a pane of thin window glass, eight or ten inches square, and let a piece of thin sheet lead be placed on each side of it, not nearer to the edges of the glass than about two inches: This being placed on the palm of the hand, may be charged by bringing the upper lead to the conductor; when it is charged, the glass may be taken hold of by the edges or corners, and the leads thrown off; the glass will still retain its charge, even though it be wiped on both sides with a dry handkerchief. To try this, let the plates of lead be cautiously replaced on the glass (it matters not whether the same lead be put on that side of the glass it was on before, or the other; or whether it be first placed on the *positive* or *negative* side of the glass.) On forming a communication, by bringing a finger of one hand to the upper side of the glass, while the lower side touches the other hand, it will be found that the glass had lost but little of its force by having the leads taken off.

THE glass may, indeed, be charged without using the leads, if it be laid on the palm of the hand, and the upper side of the glass be brought to a small chain hanging from the conductor, and moved so that the chain may touch the surface in every part of the glass that is opposite to the hand: By this means it will acquire a considerable charge; which may be known either

ther by placing on the leads as before, or by applying the palm of the other hand to the upper side of the glass.

THE glass, however, cannot be charged, that is, it cannot be made to acquire a redundancy of the electric matter on one side, and a deficiency on the other, without the assistance of some conducting substance. If one side of a pane of glass, thoroughly dry, be apply'd to the prime conductor, without any conducting substance in contact with the other, it will be found that both sides of the glass are electrified alike,—both *positively*;—and, if apply'd to a conductor negatively electrified, each side will have a *deficiency* of its natural quantity; but in either case the electricity will be but weak.

THE *force*, then, so remarkably great in an electric *explosion*, appears to be produced by the violent attraction of what may be called an electric *vacuum* and *plenum*; and the force of this attraction seems dependant on several concurrent circumstances—the impermeability of the electric body between the two powers—the perfection of the conductors in contact with the electric—the proximity of the *plus* and *minus* electricity—and the degree in which the fluid is compressed.

As the fluid could never be compressed or accumulated in any degree, unless some bodies *resisted its passage*, it follows, that the more capable any body is of such resistance, the more strongly may the fluid be compressed, before its force becomes sufficient to *penetrate* that body.—If the conducting substances, with which the electric is connected, are not sufficiently perfect to admit of a free passage of the fluid, a part only of the fluid will be transmitted through them at the instant of the explosion, and the equilibrium will not be completely restored.—The nearer the approach of the *plus* and *minus* electricity to each other,
the

the more will their attractive force be exerted, and the greater their efforts to restore the balance; perhaps, if it could be nicely determined, the ratio of the attractive power would be found to be as the square of its distance.

WHEN the charge of an electric substance is arrived to a certain height, that substance will be *penetrated* by the fluid, if it be thin enough to permit the power of the charge to overcome the resistance of the electric, or come within what may be called its *striking distance*. In this case many electric substances will be perforated by the passage of the fluid; others, less perfect in their kind, will suffer the charge to pass through them without rending.——A pane of glass, the 20th part of an inch thick, strongly charged, by means of tinfoil or sheet lead, will frequently be perforated with several holes, and the glass round the holes be pulverized to a surprising minuteness.——A plate of sealing-wax, of the same thickness, will also generally be perforated, and sometimes broken to pieces.—Baked wood will often be rent, but will more frequently permit the fluid to pass through its pores in a very fine and acute stream.

THE *air*, as an electric, we well know, resists the passage of the fluid; otherwise we never could be acquainted with any electrical appearances. The air surrounding an electrified non-electric is always, in some measure, *charged* with the fluid; for, if any other non-electric approaches that which is electrified, the surface presented towards the electrified body is always found to be possessed of a contrary electricity. But, that a *plate of air* may be charged in the same manner as other electric substances, may be rendered evident by such an apparatus as the following, which I have found to be extremely convenient for many other experiments. As the subject is curious, and seems to lead

lead to farther discoveries of the nature of the electric fluid, I shall be somewhat particular in the uses that may be made of it, hoping others, who have more leisure than myself to pursue the enquiry, may be able to improve and apply it to more material purposes.

LET two boards be made of inch deal, of an equal size, and circular form, each containing about 8 or 9 square feet of surface. It is necessary that they should be perfectly plain and level, and planed quite smooth. Let one side of both of them be nicely covered with tin-foil, smoothly pasted on, and turned over the edges; the other side of one of the boards, covered in like manner with gilt leather. The board with only the tin-foil on it, is to be insulated upon glass supporters, and placed on a table, some feet distant from the electrical machine: The other board suspended directly over it, by a pully, from the ceiling of the room; this is likewise to be insulated, by means of a silken string, and, by the pully, may be adjusted to any required distance from the other board.

IN order to electrify the air, let that side of the suspended board which has the gilt leather on it be uppermost, and the tin-foil'd surfaces of each board exactly parallel to each other, at the distance of about one inch. The upper board is then to be made a part of the prime conductor, by being connected with it by means of a chain or wire; the under board, at the same time, connected with the earth, by suspending a chain to a small hook or ring on the lower side, the end of which chain may hang down to the floor; the ring to which the chain is suspended, should have an immediate communication with the tin-foil on the other side of the board, by means of a small strip of the metal pasted over the edge of the board.

WHEN the upper board is strongly electrified, the fluid will be repelled from the under one, and driven through

through the chain into the earth, by which means this board becomes electrified *negatively*. The *space*, or, as it may be termed, the *plate of air* between the two boards, acts as a plate of *glass* or other electric, forming a kind of barrier, which, by its resistance of the fluid's passage, keeps asunder the *plus* electricity from the *minus*. In this situation, let a person take hold of the chain which hangs from the under board, and at the same time bring his other hand to the upper board, and he will immediately receive the same kind of sensation or shock as from a charged phial, and be sensible that the fluid has passed entirely through him.

IN this case it is not to be expected that the shock or explosion will be proportionably strong to the quantity of surface contained on the boards. If the boards are one inch distant from each other, and if the proportion of attraction before hinted at be admitted, it follows, that the charge will be but about one hundredth part as strong as when the two electric powers are separated by a plate of glass one tenth of an inch thick—The quantity of fluid compressed; the degree of compression, and the portion of time necessary to *charge* the apparatus, will likewise be in the same proportion.

I DON'T know that the air can be made to receive a stronger charge than this; for, if the boards are placed closer to each other than one inch, they will generally explode before they are fully charged; and sometimes the striking distance will be much farther, if there be any roughness or irregularity near the edges. When they explode, the electric matter will be seen to dart from the upper board to the under, restoring the equilibrium in the discharge of a very strong spark, attended with a loud report.

THAT a part of the natural quantity of the fluid belonging to the under board is actually repelled, and driven

driven off through the chain to the earth, may be rendered very evident; for, when the apparatus is charged, if the chain be taken away from the under board, and the upper one drawn up by the pully to some distance, the former will be found to be negatively electrified;—and, if the end of the chain, instead of touching the floor, be made to communicate with the wire of a coated phial, the phial will by this means be pretty strongly charged.

* * * THESE, and several of the following experiments will generally succeed better, when the chain from the under board (instead of hanging on the floor) is connected with the insulated rubber of the machine.

A Method of producing ARTIFICIAL LIGHTNING.

THE similarity of electricity and lightning had been frequently remarked, before the ingenious and conclusive experiments of Dr. FRANKLIN and a few other gentlemen, demonstrated that these phenomena arise from the same cause. At this time the opinion is almost generally received, that lightning and thunder are no other than the effects of an accumulation and discharge of the electric fluid. Some clouds are found to be replete with this fluid, or, electrified *positively*; others to have a deficiency, or a *negative* state, with respect to the fluid. The different and remarkable effects of these clouds have been accurately observed—the one has conveyed a *plus*, the other a *minus* electricity, to an apparatus erected for the purpose of receiving their influence.

If two such clouds, in opposite states, approach within the striking distance of each other, the one violently discharges its redundant matter to the other, which, from its deficiency, as violently receives it. When a large cloud, strongly impregnated with electricity,

tricity, descends near the earth, it generally discharges a quantity of it on the first eminence or building that it approaches; and the tremendous effects it has sometimes produced in its passage, are but too well known.

THESE effects will be the same, whether the cloud be in a positive or negative state. If it be the latter, the fluid strikes from the earth to the cloud: But in either case, the cloud probably causes whatever it strikes to be in an opposite state, before the explosion.

THE light and sound accompanying these phenomena are, indeed, so awfully sublime, that we cannot well reflect on the *weakness of humanity* when, in the ages of superstition, they were supposed to be the immediate ministers of vengeance sent from an *inraged DEITY*;—they are now more rationally considered as the natural means of restoring a necessary *equilibrium*—the rough discords of nature, productive of general harmony.

BUT these great and alarming appearances may be very innocently and agreeably imitated in miniature, by means of the two plated boards before-mentioned.—Let the upper board, which is suspended from the ceiling by silk, be turned the contrary side downward to what was before directed, viz. let the side which has the gilt leather on it face the lower board, at the distance of an inch and a half. On the surface of the lower board may be placed one or two small metal hemispheres—these may serve to represent hills or eminences; the board itself, a spacious plain; and the upper one, a large electrified cloud;—let this board be connected to the prime conductor of the machine, and the lower one to the rubber. The apparatus thus disposed, upon turning the machine (if it acts vigorously, which is always supposed in these experiments) the upper board will be seen to discharge all the force of its contents on one of the metal hemispheres, in a strong flash, attended with a smart explosion; at the same time, the

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gilt

gilt surface of the upper board will exhibit a most beautiful appearance; vivid corruscations of electric light will be seen to dart over it in various directions, with an exact resemblance of lightning. This, indeed, is more than an *imitation*—it is nature invested with her own attire.

IN order to represent a cloud *negatively* electrified, let the lower board be connected to the prime conductor, and the upper one to the rubber; the appearances will be nearly the same, but the experiment generally succeeds better this way than the other.—If a small coated phial be made use of in this experiment, and connected with the apparatus so that it may explode with the boards, the flashes of light will extend still farther, and the explosions be more loud.

THE effects of lightning on buildings, &c. together with a method of preserving them, are agreeably shewn by a small appendage called a *Thunder-House*, resembling the side of a house or pile of building. A brass wire is let into it from the top to the bottom, but so contrived, that the connection may be occasionally broken in the middle part of it, by inverting a small piece of wood wherein part of the wire is inserted. This may be used separately, or with the boards, in the lightning experiment. When the discharge is made, the piece of wood will be blown out to a considerable distance by the lateral force of the explosion, when the connection is broken; but if the wood be placed so as to render the connection of the wire complete, the electric matter will pass through it, and the wood remain undisturbed by the explosion.

ON the top of the wire (which represents the *conducting-rod* of a building) a small brass ball is generally fixed, and another on the end of a wire communicating with the prime conductor and inside of the phial: Between these two balls the explosion is received,

ed, when the charge has acquired a sufficient degree of strength; but if one of the balls be taken off, and the point of the wire exposed to the other ball, no explosion can be produced, the point drawing off the electric matter in a small stream. And it is observable, that, in the foregoing experiment, if a fine pointed wire be made to project a little way from one of the metal hemispheres, the boards cannot in any degree be charged, the wire receiving all the fluid from the upper board as fast as the machine can produce it. A large jar, or even a battery may be almost instantly discharged without any explosion, by bringing the point of a needle near the wire of it; so powerful an effect have points in receiving and throwing off the electric matter.

It was from observations of this kind that Dr. FRANKLIN supposed it to be very practicable to draw the electric matter from the clouds during a thunder storm, by means of pointed iron rods projected from the tops of buildings, &c. and, on the trial, finding it to answer his expectations, he very justly concluded, that these iron rods or conductors, might be successfully used as means of securing such buildings as were much exposed to lightning, from its dreadful effects. The conductors were accordingly erected, and the buildings really secured.*

THE Doctor also observed, that those buildings which are covered with lead, and have leaden spouts continued from the roof into the ground to carry off the water, are never hurt by lightning, as whenever it falls on such a building, it passes in the metals, and not in the walls.

HE adds ‘ When other buildings happen to be with-
 ‘ in the striking distance from such clouds, the fluid
 ‘ passes in the walls, whether of wood, brick or stone,
 s 2 ‘ quitting

* See FRANKLIN'S Letters.

‘ quitting the walls only when it can find better conductors near them, as metal rods, bolts, and hinges of windows or doors, gilding on wainscot, or frames of pictures; the silvering on the backs of looking-glasses; the wires for bells; and the bodies of animals, as containing watry fluids. And in passing through the house it follows the direction of these conductors, taking as many in its way as can assist it in its passage, whether in a strait or crooked line, leaping from one to the other, if not far distant from each other, only rending the wall in the spaces where these partial good conductors are too distant from each other.

‘ AN iron rod being placed on the outside of a building, from the highest part continued down into the moist earth, in any direction, strait or crooked, following the form of the roof or other parts of the building, will receive the lightning at its upper end, attracting it so as to prevent its striking any other part; and affording it a good conveyance into the earth, will prevent its damaging any part of the building.— If the building be very large and extensive, two or more rods may be placed at different parts, for greater security.

‘ A PERSON apprehensive of danger from lightning, happening during the time of thunder to be in a house not so secured, will do well to avoid sitting near the chimney, near a looking-glass, or any gilt pictures or wainscot; the safest place is in the middle of the room, (so it be not under a metal lustre suspended by a chain) sitting in one chair, and laying the feet up in another. It is still safer to bring two or three mattresses or beds into the middle of the room, and folding them up double, place the chair upon them; for they not being so good conductors as the walls, the lightning will not chuse an interrupted course through
‘ the

‘ the air of the room and the bedding, when it can go
‘ through a continued better conductor the wall. But,
‘ where it can be had, a hammock or swinging bed, suspended by silk cords equally distant from the walls on
‘ every side, and from the ceiling and floor above and
‘ below, affords the safest situation a person can have
‘ in any room whatever, and what indeed may be deemed
‘ quite free from danger of any stroke by lightning.’

BUT as very few people are sufficiently provident to have at hand such a swinging bed as above, I apprehend it will seldom or never be used; what would answer the purpose nearly as well, and which might always be ready for use, is one of the insulated boards before mentioned; a person sitting in a chair placed on such a board in the middle of the room, need not be under any great apprehension from the effects of lightning.

IT has been objected to the use of *pointed rods* for the purpose of securing buildings, that they have too powerful a tendency in attracting the lightning to the building whereon they are fixed; that probably, in a violent thunder-storm, a larger quantity may be received by means of such points, than can be conveyed off by the conductor, unless it be very large, without some injury to the building; and that rods made *blunt* or round at the top would be better adapted to the purpose, as being less liable to *invite* the lightning, and, in case of an explosion, altogether as safe, and sufficient to conduct it off.

DR. FRANKLIN, however, appears to have been of a different opinion, and supposes that the pointed rods will not only *conduct* a stroke of lightning with safety to the building, but that they have also a probable tendency to *prevent* a stroke, and that this is one intention of their being made pointed: “ But, says he, to have
“ a better chance of obtaining this end, the points
“ should

“ should not be too near to the top of the chimney,
“ or highest part of the building to which they are
“ fixed, but should be extended five or six feet above
“ it; otherwise their operation in silently drawing off
“ the fire (from such fragments of cloud as float in
“ the air between the great body of cloud and the
“ earth) will be prevented.”^y

It must be owned that the circumstance of *silently drawing off* a part of the electric matter from the clouds is a very desirable one; and though the points may never absolutely *prevent* a stroke, yet, if they are capable of effecting a *protraction* of it, by receiving, for the space of a few seconds prior to the explosion, a part of the fluid in the form of a *current*—this might probably be the means both of *directing a passage* for the fluid, and of *lessening the force* of the stroke, which chiefly consists in *the whole* being conveyed in an *instantaneous explosion*.

THAT such *points* have at least a probable tendency to *lessen* an explosion by first receiving the fluid in a gradual manner, I apprehend will appear pretty evident (if the analogy between electrical experiments and the great operations of nature be allowed) from what was before observed on the discharging of large jars by means of points—a jar, or a considerable number of them, being charged, and a brass ball fixed to the end of the chain that communicates with the outside having a very fine pointed wire, about an inch long, projecting from it; if this point be brought near the prime conductor, a current of the fluid will issue from it to the point; as soon as the point is brought nearly to touch the conductor there will be an explosion, but not a fourth part, perhaps, so forcible as it would have been without the point. If the point be held for three or four seconds within half an inch of the conductor, the jars will be discharged without any explosion.

BESIDES,

^y FRANKLIN'S letters.

BESIDES, it seems probable that pointed rods erected some feet higher than the top of a building, may have a tendency to prevent the building itself from acquiring so great a degree of a contrary electricity to the cloud as it otherwise would, and on which the violence of the explosion in some measure depends; for we may reasonably suppose the atmosphere between the cloud and the earth, before a stroke of lightning, to be in some degree *charged* with the electric fluid. If the cloud be in a *positive* state, the eminence or building that it approaches, and perhaps a great extent of ground under it, will be *negative*; and the contrary if the cloud be negative.

THAT points have this effect of rendering the surface they are projected from less capable of acquiring a contrary electricity to that of the electrifying body, appears not only from the effect of a point projected from the surface of one of the boards, before mentioned in the lightning experiment, but from numberless others.—I consider the *point* itself as always *positively* electrified, whether it be *receiving* or *throwing out* the fluid, and so far from being at any time in a *negative* state, that, in either case, the fluid must be greatly condensed there.

It seems then to be rather contrary to *electrical* appearances, to suppose that a *point*^z is capable of producing an *explosion* where there would have been none in the absence of the point; for, by facilitating the entrance (or exit) of the fluid, it has an evident tendency to *lessen*, and sometimes totally *prevents* an explosion, the force of which is apparently *increased* by the resistance of large surfaces. BUT,

^z By *points* I would here be understood to mean wires terminating extremely acute, such as the point of a fine needle; a rod of iron terminating in the size of a goose quill may, in some cases, be termed a *point*, but such a point as this will receive an electric explosion at a greater distance than a metal ball of an inch diameter.

BUT, after all, it may be questioned whether any of our little experiments in electricity are sufficiently analogous to the sublime operations displayed in the heavens, to point out with any degree of certainty what will, or will not be the effects of these pointed rods during a thunder-storm;—having no greater an elevation than a few feet above the top of a chimney, and being seldom more than a few inches in circumference, perhaps they can have but little effect in drawing off any considerable quantity of the electric matter from a thunder-cloud: Some of these clouds are of a stupendous magnitude; and such a conductor seems to bear but a very inconsiderable proportion to a cloud of ten thousand acres extent, fully charged with electric particles, as Dr. FRANKLIN supposes some of them to be.—The rods, however, are generally found from experience to be struck by such parts of the cloud as approach near enough to them, and to convey to the earth the quantity of lightning they receive without injury to the building: And it has been known, that a conductor no larger than a curtain-rod, and even a bell-wire has conducted, with safety to the building, a stroke sufficient to shatter every part of it that was not connected with conducting substances.

BUT, whether it may be thought most proper to have the conductors *elevated* and reduced to a *point* or otherwise, for greater security it will undoubtedly be advisable to make them of a size much larger than a common curtain rod, as we cannot say how great a quantity of the fluid may one time or other pass through them. The largest conductors I have heard of are those of St. PAUL's Church, at London; which, in some places, are four inches broad and half an inch thick; not of the same form throughout, but varied conveniently to the form of the building. Notwithstanding there were four of these large conductors, the stroke of lightning they received on the 22d of
March,

March, 1772, (which at the same time struck the Chapel in *Tottenham-court Road*) appears to have made one of them red hot.—The cross on the top of that edifice being sufficiently elevated, the conductors were not projected above it with any sharp points;—but I don't find that the building was any way damaged by the lightning.

WHEN conductors are not large enough to convey the quantity of fluid forced into them, and afford it a free passage to the earth, they will suffer so violent an agitation by the rapid current of the fluid, that they will either be rendered glowing hot and melted, or else consumed and totally exploded: In either case, especially the latter, that which is to be dreaded from its effects is the *lateral force* of the explosion;—when the fluid is obstructed in its passage by a conductor too small, it bursts from it in any direction, to the next nearest conductor, rending in its way whatever resistance it meets with, that is, almost every thing but metals.

BUT, in the Experiments I have made with large jars and batteries, I never could observe that this lateral force was in any degree exerted except where an explosion was produced: By an *explosion* I here mean the passage of the fluid through the *air*, when the chains or wires that formed the communication were not in contact with each other—when the fluid has passed over the surface of any imperfect conductor without entering it—or when a wire has been melted and dispersed by being too small to conduct the fluid; in these cases I always found the lateral force very considerable in every place where the fluid thus visibly passed thro' the air. When the charge is strong, and a small steel wire forms a part of the circuit, it will be instantly exploded and dispersed, and large glowing sparks be driven from it with great violence, in all directions, to

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the distance of eight or ten feet. If bran or any light substances are laid near it, they will also be blown away; this will likewise generally be the case, when such substances are laid near the place where the ends of two wires meet, or on a chain, the links of which are seldom in absolute contact: But when the circuit was formed by one long wire, though a small one, and the force of the charge very considerable, I never found the least appearance of a lateral force; even feathers and the lightest substances that were laid on it, were not stirred by the explosion.

A SMALL wire three inches in length will conduct a great force of electricity perfectly well; but if the same wire be no more than two inches, a much less force will entirely consume it; and a wire that in *one piece* would have conducted the charge, if it be joined in the middle by a link, it will be melted and an explosion produced in that place.

FROM hence I apprehend that conductors for the preservation of buildings would best answer the purpose, if they were to be made of one continued rod or bar of iron; but where this cannot be done conveniently, it should be contrived that the joinings be in places detached from the walls and other parts of the building, and the parts of the joints forced as close as possible in contact; That the conductors, if they can conveniently, be at the outside of the house, and either detached from it at some little distance, or fixed to the wall, not by iron cramps, but by wedges of wood, pitched ropes, or some other substance that is an imperfect conductor. Whether they be reduced to a perfect point at top or not, it seems necessary for several reasons that they should have some degree of elevation above the highest part of the building, and the lower end run several feet into the earth in a direction oblique from the foundation.

Of

Of the AURORA BOREALIS, METEORS, &c.

SINCE electricity has become a material topic of philosophical enquiry, it has thrown new light on a variety of interesting subjects, and has been the means of elucidating the cause of many appearances in nature upon rational principles, which before was rendered more obscure by desultory conjecture. It seems to be the current opinion of those who have considered the subject, that the *Aurora Borealis* is occasioned by the flashings of the electric fluid from clouds positively electrified, to other distant ones that are either in a contrary state, or less electrified, through a very rare medium of air, where there is little or no resistance to its passage.

A VERY perfect representation of this may be obtained by means of a double barometer-tube, bent in the middle so as to form a kind of an arch. This is to be filled with quicksilver, and each end of the tube inserted into a small basin of the same fluid. When the tube is erected, the quicksilver will quit the upper part, and stand in each of the legs at the same height as in a common barometer, leaving a very perfect vacuum in the top of the arch. If this part of the tube be connected to the prime conductor of the electrical machine by means of a chain or wire, it will occasion a beautiful appearance of the electric light *in vacuo*, with various flashings and vibrations like the northern lights. The wire of a small charged phial apply'd to the upper part of the tube will produce the same effect; and, in dry weather, the flashes will continue for a considerable time after the phial is removed.

ANOTHER way of producing this appearance is with a single glass tube, exhausted of air and hermetically sealed. If this tube be rubbed with a woollen cloth

it will become luminous, but much more so if apply'd to any electrified body. When the tube is excited with a very vigorous electricity, particularly the negative, the corruscations will be exceedingly vivid and brilliant; and if the hand be apply'd to the end of it, a bright spark will sometimes dart along the tube like a meteor in the air.

The Electrical WHIRLWIND and WATERSPOUT.

IT has been supposed by some ingenious men, that Waterspouts, Whirlwinds, and even Earthquakes are likewise produced by the influence of the electric fluid, when formed into certain modifications with respect to the state of the air, situation of the country, &c.*

To form some kind of representation of the *waterspout* by electricity, let the two boards be adjusted in the manner before directed for electrifying a plate of air, but somewhat farther distant from each other. A small glass cup nearly filled with water is to be placed on the under board, and a narrow strip of tinfoil pasted over the edge of the cup, so that one end may touch the water, and the other the plated surface of the board. Directly over the middle of the cup of water, a small brass ball may be made to project from the upper board, about half an inch distant from the surface of the water, and the lower board connected with the insulated rubber by a chain. When the machine is put in motion, the water will be seen to acquire a convex surface, rising in the centre; small particles of it will sometimes fly from it to the ball, while the ball throws out a lucid stream to the water.

If the ball be made wet, so that a drop of water may hang from it, the drop will be formed into the shape of

* See PRIESTLEY's Hist. of Electricity.

of an inverted cone; and a cone of electric light (the base of which will be on the surface of the water in the glass cup) will be seen to issue from the cone of water; This will exhibit the curious appearance of a double cone, half water and half fire.

THIS experiment may be performed in another manner, by placing the cup of water on the upper board, and bringing the end of a discharging rod (having a brass ball to it) near the surface of the water: The appearances will be nearly the same as before, except that, in order to procure the double cone, the cup of water must be negatively electrified.

IN order to represent the appearance of a *whirlwind*, let the boards be placed in the manner before directed, but four or five inches apart; first placing a quantity of bran and very small pieces of thin paper in the centre of the lower board. When the machine is set in motion the paper and bran will be agitated in a very amusing manner, being attracted and repelled between the two boards with surprising rapidity. The chain from the under board may be taken off, and the board now and then touched with the hand, which gives a pleasing variation to the motion of the bran. If the lower board be connected to the insulated rubber, the motion will increase and be very rapid—when the chain is taken off it will not be so violent—if the upper board be touched the motion will be still more languid, and if both boards are touched at the same time all motion of the bran will immediately cease.

BUT the most surprising appearance in this experiment, and what gives it the most exact resemblance of a whirlwind, is, that sometimes, when the electricity is very strong, a quantity of the paper and bran will accumulate in one place, forming a kind of column between the boards, and suddenly acquire a swift horizontal motion, moving like a whirling pillar to the edge

edge of the boards, and from thence fly off and be scattered about the room to a considerable distance. I own I am entirely at a loss to account for this extraordinary appearance—I call it extraordinary because it but seldom occurs, and seems to depend either on a certain degree of attraction, quantity of the bran, or distance between the boards; and I could seldom get it to succeed perfectly but by accident.

*The different Appearance of POSITIVE and
NEGATIVE Electricity.*

ONE of the first enquiries naturally made by those who are unacquainted with electrical appearances, when they draw a spark from the prime conductor, is, Whether the fire proceeds from the conductor, or from the body that is made to approach it? The rapidity of motion in the spark frequently deceives the eye, and we may often fancy it proceeds from the one, while, in fact, it comes from the other. I have sometimes been a little diverted with the contention of two persons who have stood opposite to each other,—one has insisted that it came from the conductor, while the other was as positive that he saw it proceed from the discharging-rod: I have desired them to change places with each other—they then both began to doubt of their former opinion; but were generally convinced by the following experiment.—Take a brass rod about a foot long, through which are inserted ten or a dozen small wires; each end of the wires projecting from the rod about one inch, in opposite directions: Let the rod be insulated on a glass stand, and the ends of the wires placed parallel to, and within an inch distance from the negative conductor.^b In this case whenever the finger is apply'd to the top of the glass stand, fine
streams

^b We still suppose the negative conductor to be of the same form and size as the positive, or prime conductor.

streams or pencils of electric light will be seen to issue from the ends of the wires to the conductor, while the remoter ends will be only illuminated with a small star or speck of light.—If the rod of wires be removed from the negative, and placed at the same distance from the positive conductor, the appearance will be just contrary; the small stars will be seen at the ends of the wires nearest to the conductor, and the streams issue from the other ends.

THERE is also as remarkable a difference in the *spark* itself, when drawn at a considerable distance. To do this the electricity must be vigorous, the conductor very large and well insulated: A brass ball of about an inch diameter should be made to project from the end of it. Sparks may then frequently be drawn from the ball at the distance of six, eight, or ten inches. Dr. PRIESTLEY lately informed me that he has, by this means, drawn sparks more than thirteen inches in length. These long sparks have a very curious appearance: They never fly in strait lines, but form various curves and odd directions in their passage. If taken from the *positive* conductor, they come out small, and expand broad before they enter the discharging-rod; on the contrary, when they are drawn at the *negative* conductor, they appear large at the conductor and small at the rod. A spark equally long may be drawn at the negative conductor as from the positive, if the rubber be properly insulated; but with this difference; that they come off longest from the *end* of the positive to a *broad* surface, and from a *narrow* surface to the *middle* of the negative.

WE are not to suppose that the electric spark is actually *extended* in its passage to the same length and form as it appears to our sight;—this is only a *deceptio visus*, like that of a *circle of fire* produced by a fire-brand when whirled round with a string. The fluid,
indeed,

indeed, advances in the crooked direction that we see it, occasioned by the resistance of the air; but I rather conceive, that in these *explosions* the particles of the fluid being accumulated and greatly compressed at the place where they issue from the conductor, they rush off in a *conical* form, and in the instant that they are detached from the conductor, they form themselves into a *sphere*, which, by the natural repulsion of its component particles, expands and enlarges till it is enveloped in the mass of matter that attracted it.—But this, indeed, is merely a conjecture, and may be contrary to fact.

An Electrical PLANETARIUM.

BY the attractive and repulsive powers of electricity a great variety of amusing mechanic appendages might be added to an electrical machine, whose motions might be varied and regulated almost at pleasure. Among others, a kind of *electrical orrery* or *planetarium* has been invented, consisting of small glass spheres, blown extremely thin: These are placed on a metal plate, and environed with circles of thick brass wire, insulated with sealing-wax or glass; of such a height from the plate that the centre of the glass spheres may be parallel to the wire circles. One of these circles may represent the orbit of *Saturn*, another of *Jupiter*, &c.—and a brass ball may be placed in the centre for the *Sun*. These circles being connected with the conductor of the machine by a wire, and a glass sphere placed between each, the spheres will perform their revolutions round their orbits; and, at the same time, acquire a rotation on their axes, or the point which touches the metal plate.—These movements of the glass spheres may convey some idea of the annual and diurnal motion of the earth and other planets, but a very imperfect one of the *cause* of that motion.

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THE revolutions of the glass balls are no other than the necessary consequences of electrical attraction and repulsion, as before explained: On the same principles they might be made to move in a strait line across the chamber, or in any other direction. When the machine is set in motion the balls will be first attracted to the brass circles, by which means the point that touches the circle will become electrified, and then be immediately repelled; the electric matter being but partly diffused over the surface of the glass, other parts of the surface will be successively attracted and repelled by the brass ring, while the electric matter is discharged on the metal plate: This must consequently give the glass ball a kind of spinning motion on the point which touches the plate, at the same time that it must have a progressive motion round the circle.

THIS experiment will succeed best if the metal plate be likewise insulated on the circular board before-mentioned, and connected by a chain to the negative conductor: Or, the plate may be electrified by the *prime* conductor, while the circles are in contact with the other.

The Effects of FLAME in Electricity.

FLAME appears to be a very good conductor of the electric fluid. As it may be supposed to consist of an almost infinite number of minute particles of that matter which it consumes, it has as powerful (and perhaps greater) tendency to receive and throw off the electric fluid from a body electrified, as the most acute *points*.——If a lamp, made of metal, be placed on an insulated stand (to which a prime conductor may be connected) and the flame of it placed a few inches distant from the electrical glass cylinder, the flame will be found to collect and conduct the electricity full as well as the pointed wire collectors; and strong

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sparks

sparks may be taken from the prime conductor.—A candle will not do so well in this experiment, the tallow and cotton being bad conductors, unless one end of a wire be made to touch the flame, and the other end connected to the prime conductor.—If a small coated phial be held by the hook, and the outward coating be brought within an inch or two of the flame of the lamp, or of a candle, it will be strongly charged in a short time.^c

TAKE a coated phial, containing about a pint, with a small brass ball at the end of the wire, and charge it *positively* at the inside; then apply one end of the discharging-rod to the outside coating, and hold the flame of a candle between the other end of the rod and the wire of the phial, about an inch distant from each; the flame will by this means be strongly blown from the ball of the phial towards that of the discharging-rod; but if the phial be *negatively* charged, the flame will have a contrary direction—from the discharging-rod to the phial.

If the phial be highly charged it will explode at more than two inches distance through the flame of the candle; the electric light appearing generally of a curious blue colour. But this experiment has a much finer effect when performed in the following manner;—Let the large insulated board (so often before mentioned) be once more introduced, and placed on the table; then charge one phial *positively*, very highly, so that the electric fire may stream out at the small ball at the end of the wire; let another phial of the same size be charged equally strong with the *negative* electricity; place both the phials thus charged on the board,

^c I should think it would be a desirable discovery, if an accurate method could be thought of for determining the difference (if any) between flame arising from *oleaginous* and other substances, with respect to its conducting power.

board, so that the knobs may be four or five inches from each other—if the flame of a candle be then brought between the two knobs, the phials will both explode with a loud report, and a strong spark fly from one ball to the other with a very curious appearance. I have frequently made the phials explode in this manner at more than six inches distance; in which case the spark will have the same curved or crooked direction as when drawn from the end of a large conductor.

THE following is a very beautiful experiment, when it is made to succeed properly,—take the two phials, charged as before, (but phials of a larger size are better for the purpose) and place them as far from each other as the board will admit of; let a range of candles be then inserted in a frame or piece of wood, about two inches distant from each other, the flames of each exactly parallel; when these candles are quickly introduced between the knobs of the phials, the spark will be seen to dart through all of them, and have the appearance of a line of fire variegated in a thousand different curves.

The Effects of ELECTRIFIED WATER.

IT is extremely entertaining to behold a matter which has the appearance of fire proceed immediately from a body of water. A stream of *fiery water* seems rather an hyperbole than a real fact; But such appearances are easily produced.——Let a pewter basin be placed on the insulated board, and connected to either conductor; a small stream of water being then poured into the basin from another vessel, will, when the room is darkened, assume a very lucid and curious appearance; the stream, before it reaches the basin, will be divided into a great number of very small

drops, and each being illuminated, will appear like a fiery rain.

If a capillary glass syphon be suspended from the conductor in a small bucket of water, though the water falls from it only in small drops, yet upon turning the machine it will issue out in a full stream, with a luminous appearance. But a method or rendering this experiment much more beautiful is the following—Take two of the fore-mentioned syphons and buckets of water, and suspend one of them from the positive, the other from the negative conductor, at such a distance from each other that the ends of the syphons may be about three or four inches apart; when the machine is set in motion the two streams will attract each other, and sometimes, beautifully uniting, form themselves into one;—the illumination of the streams will also afford a very pleasing sight in a dark room.

If the buckets are suspended on two *positive*, or on two *negative* conductors, the streams of water will repel and recede from each other as much as they were before attracted.

If a pretty large glass vessel, about three parts full of water, be held under the prime conductor, with a chain or wire hanging from the conductor so that the end of the chain may touch the surface of the water, (taking care to keep the upper part, and all the outside of the glass vessel quite dry) the water will become electrified, and continue so for some time after it be taken from the conductor, and a spark may be drawn from its surface. Were a person to grasp the glass vessel with one hand, while the water is electrifying, and at the same time bring his other hand to the conductor, he would experience the same kind of sensation that so greatly terrified Professor MUSCHENBROECK, and produced the discovery of the *Leyden phial*.

ELECTRICIANS are now not quite so apprehensive of *danger* in repeating this experiment as the Professor was;—They have sometimes given it an agreeable variation by substituting a beaker of *wine* or *punch* in the place of simple water; and having *charged* the *electrical bumper*, in the manner before mentioned, they have drank it off in social good humour to the memory of that lucky event.

DR. FRANKLIN, some years ago, with other gentlemen, concluded a campaign of electrical operations in a very agreeable and humorous manner, in a party of pleasure on the banks of the *Skuykil*, in *Philadelphia*. They fired spirits by an electrical spark conveyed thro' the river. A turkey was then killed for their dinner by the electrical shock, and roasted by an electrical jack, before a fire kindled by the electrical bottle; when the healths of all the famous electricians in *England*, *Holland*, *France*, and *Germany*, were drank in *electrified bumpers*, under a discharge of guns from the electrical battery.^d

I CANNOT help thinking but that a few of these *electrified bumpers* at a "Feast of Reason," would generally prove to be an excellent *specific* against the various disorders arising from *spleen*, *vapours*, and *ill-humour*—provided they are not of too long standing.

A GREAT force of electricity may be conveyed thro' a body of water.—Set a pewter basin on the insulated board, in contact with the prime conductor, and let a coated phial be likewise connected with it, so as to become charged; the phial may either be placed on the ground, or on the table, with a chain from the outward coating hanging down on the floor. If we would chuse to conduct this experiment in a manner somewhat *mysterious*, a quantity of thin sheet lead,
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spread

^d FRANKLIN'S Letters, p. 37.

spread over the floor of the room, may be concealed under a carpet. When the phial is charged, let a person take a tea-kettle (or any other metal vessel) of water in his hand, and pour a stream into the basin; and he will immediately receive a forcible vibration through the whole body, from his hand to his feet. This may not improperly be called the *aquatic shock*, which would be apt to surprise an electrician himself, if he was not aware of his standing on lead.

Thus we may cause a train of gunpowder to be fired, a cannon to be discharged, or a candle lighted by pouring a stream of cold water from one vessel to another. But as a person is not always disposed to receive these *aquatic shocks* through his body, he may have a vessel made with a glass handle to it, and complete the circuit by the addition of a chain; but the most convenient thing for the purpose is a copper tea-urn, which by turning the cock would produce a proper stream.

When a long narrow trough of water is made a part of the circuit in the discharge of a large jar or battery, if a person's hand be immersed in the water at the time of the explosion, he will feel an odd kind of vibration in the water, occasioned by the passage of the electric fluid through it, but a very different sensation from that of the shock.

The electric shock may be conveyed through a very large body of water, by making it a part of the circuit. —It has been done more than once through the river *Thames*, by Dr. WATSON and others.

Of the ELECTRICAL BATTERY.

A Great number of coated phials connected together, so that all their force may be combined in one explosion, is called an *electrical battery*. These phials

phials are generally ranged in a wooden frame or box, covered at the bottom with sheet lead or tinfoil; from this projects a thick wire hook, which serves as a communication to the outside of all the phials; and the insides are all connected by small rods of metal laid over the mouths of the phials.

WITH such a force as this (supposing the battery to contain thirty or forty square feet of coated glass) a great number of surprising and interesting experiments may be performed; and though it be a very formidable appendage to the electrical machine, and ought always to be used with caution, yet we cannot say that the apparatus of an electrician is complete without it, as many experiments which are necessary to be made, in order to ascertain the nature and power of electricity under various circumstances, can be performed by no other means; and I am persuaded that the satisfaction every electrician must receive from the use of this appendage, will sufficiently repay him for the labour and expence he may bestow in constructing it, which, indeed, need not be very considerable.

“ THE discharge of a large electrical battery (says
“ Dr. PRIESTLEY) is rather an awful than a pleasing
“ experiment, and the effects of it, in rending various
“ bodies, in firing gunpowder, in melting wires, and
“ in imitating all the effects of lightning, never fail
“ to be viewed with astonishment.”

